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ASSESSMENT OF SOIL FERTILITY, QUALITY AND PROFITABILITY OF CUCUMBER GROWN IN SHADE NET HOUSE WITH VERMICOMPOST, WOOL WASTE AND N.P.K. FERTILIZER APPLICATION

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Protected cultivation provides a favorable microclimate for high-value vegetable crops like cucumber (*Cucumis sativus* L.), enabling enhanced yield and quality. However, continuous use of chemical fertilizers in such systems can lead to soil degradation and declining produce quality. This study was conducted to evaluate the impact of integrating organic nutrient sources vermicompost and wool waste with inorganic fertilizers (NPK) on soil physico-chemical properties, fruit quality and the economic viability of cucumber cultivation under a shade net house. A field experiment was laid out in a Randomized Block Design with nine treatments comprising different combinations of vermicompost, wool waste and NPK fertilizers. The observations included soil parameters (organic carbon, pH, available P_2O_5 and K_2O), fruit quality traits (total soluble solids, ascorbic acid and moisture content) and economic indicators (cost of cultivation, gross return, net return and benefit-cost ratio).

ABSTRACT The results indicated that integrated nutrient management significantly influenced soil fertility, crop performance and profitability. Among all treatments, the treatment T_9 (NPK - 100% + 10t/ha wool waste) was the most effective. It recorded the highest organic carbon content (0.89%), improved nutrient availability (Organic carbon: 0.136 %, P_2O_5 : 20.99 kg/ha, K_2O : 261.17 kg/ha) and enhanced fruit quality with maximum TSS (4.10 °Brix) and ascorbic acid content (4.11 mg/100g). T_9 also yielded the best economic returns with a benefit-cost ratio of 2.60 and higher net returns per hectare (Rs. 733900), indicating high profitability under integrated nutrient practices. The study concludes that partial substitution of chemical fertilizers with organic inputs like vermicompost and wool waste not only maintains soil health and enhances fruit quality but also improves farm profitability under protected conditions. This approach offers a sustainable alternative to conventional nutrient management in high-tech horticulture.

Key words: *Cucumis sativus* L., quality, vermicompost, wool waste and NPK.

Introduction

Cucumber (*Cucumis sativus* L.) belonging to the family *Cucurbitaceae*, is one of the most widely cultivated and consumed vegetables across the world. It is a warm-season, herbaceous annual crop, mainly grown for its tender, juicy fruits that are consumed fresh as salad or used in pickles and juices. Botanically, cucumber is a creeping or climbing vine with tendrils, large leaves, shallow root system and unisexual flowers. It exhibits monoecious flowering behavior (male and female flowers borne separately on the same plant) and is primarily cross-

pollinated due to insect activity globally, cucumber is cultivated in more than 2 million hectares, with a production of over 91 million tonnes as per FAO statistics (2023). Major cucumber-producing countries include China, India, Russia, Turkey and the United States. In India, cucumber is cultivated across both open and protected environments, with an area of approximately 76,000 hectares and annual production of around 1.15 million tonnes (NHB, 2023). It is commonly grown in states like Karnataka, Andhra Pradesh, Maharashtra, Tamil Nadu, Haryana and Rajasthan especially in peri-urban and semi-arid regions

due to its adaptability and short duration. Protected cultivation has emerged as a viable technology for increasing productivity, improving quality and ensuring year-round availability of high-value vegetable crops. Among the crops suitable for cultivation under protected conditions, cucumber holds a prominent place due to its high market demand, short duration and responsiveness to favorable microclimatic conditions (Singh *et al.*, 2021). However, intensive cultivation practices, especially the overuse of chemical fertilizers in protected structures, have raised serious concerns regarding soil degradation, nutrient imbalance, declining produce quality and environmental sustainability. Cucumber is not only a refreshing salad vegetable but also an important source of hydration and nutrients. It contains over 95% water along with essential vitamins (notably vitamin C and K), minerals (like potassium and magnesium) and bioactive compounds that contribute to its health-promoting properties. The crop's economic and nutritional significance has led to its increased adoption by farmers, especially in peri-urban regions where demand for fresh, off-season vegetables is high. In addition to its nutritional content, cucumber is known for its antioxidant properties due to the presence of flavonoids and tannins, which help in reducing oxidative stress. Its anti-inflammatory, anti-diabetic and skin-soothing properties make it a popular ingredient in natural medicine and cosmetics (Kumar *et al.*, 2019).

However, the intensive use of chemical fertilizers, especially under protected cultivation, poses a serious threat to soil health and long-term productivity. Continuous application of NPK fertilizers without the replenishment of organic matter can deteriorate soil structure, reduce microbial biodiversity and lead to nutrient leaching and environmental pollution (Ghosh *et al.*, 2012). This calls for a balanced and sustainable approach to nutrient management. Integrated Nutrient Management (INM) offers a viable solution by combining the immediate nutrient availability of inorganic fertilizers with the long-term benefits of organic amendments. Vermicompost, a stabilized organic product obtained through the breakdown of organic matter by earthworms, is known to enhance soil fertility, microbial activity and plant growth. It supplies essential nutrients and improves the physical, chemical and biological properties of the soil. Wool waste, an unconventional but promising organic amendment, is rich in slow-release nitrogen in the form of keratin. Its application in agriculture not only recycles waste from the wool industry but also contributes to improving soil organic carbon and nutrient retention capacity (Scholzet *al.*, 2015). When combined with vermicompost and NPK,

Table 1: Details of the treatments used in study.

S. No.	Treatment Notation	Treatment Combination
1.	T ₁	Control
2.	T ₂	NPK - 50%
3.	T ₃	NPK - 100%
4.	T ₄	10t/ha Vermicompost
5.	T ₅	NPK - 50% + 10t/ha Vermicompost
6.	T ₆	NPK - 100% + 10t/ha Vermicompost
7.	T ₇	10t/ha Wool waste
8.	T ₈	NPK - 50% + 10t/ha Wool waste
9.	T ₉	NPK - 100% + 10t/ha Wool waste

wool waste may help in optimizing nutrient availability and crop performance under protected cultivation.

Materials and Methods

The present investigation was conducted at the shade net house at National Seed Project, Department of Horticulture, College of Agriculture, Bikaner, SKRAU, Bikaner during *kharif* season 2024. The experiment was laid out in a Randomised Block Design with nine treatments (Table 1) replicated thrice under Bikaner agro climatic condition.

A basal dose of 10t/ha vermicompost and 10t/ha wool waste was applied in relevant treatment combination plots before sowing of seeds. Nitrogen was applied in the form of urea in two split doses out of which half dose applied at the time of planting and rest was applied during flowering stage. Phosphorus and potassium were applied in the form of di-ammonium phosphate and murate of potash respectively at the time of sowing. The fertilizer as per treatments was thoroughly mixed in the soil with the help of weeding hoe. Soil samples from the experimental plot was taken and analysed by adopting the standard procedure. Both wool waste and vermicompost used in the experimental plots after proper analysis. Total soluble solids were estimated from 2nd

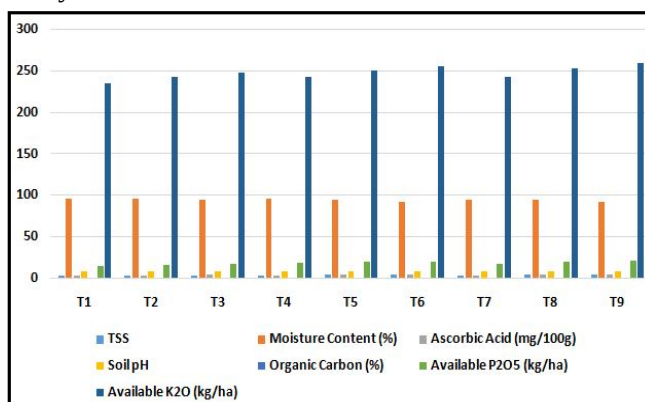


Fig. 1: Impact of Organic Amendments and NPK Fertilizers on Soil Parameters and Fruit Quality under Protected Cultivation.

Table 2: Impact of Organic Amendments and NPK Fertilizers on Soil Parameters and Fruit Quality under Protected Cultivation.

Treat-ments	TSS (°brix)	Moisture Content (%)	Ascorbic Acid (mg/100g)	Soil pH	Organic Carbon (%)	Available P ₂ O ₅ (kg/ha)	Available K ₂ O (kg/ha)
T ₁	2.15	95.80	2.67	8.17	0.103	14.63	234.43
T ₂	2.36	95.27	2.80	8.15	0.105	15.33	241.97
T ₃	3.08	94.51	3.27	8.14	0.109	16.17	247.27
T ₄	2.54	95.10	2.90	8.12	0.127	17.94	241.60
T ₅	3.60	93.72	3.57	8.11	0.131	18.93	249.67
T ₆	3.95	91.98	3.97	8.09	0.134	19.76	255.17
T ₇	2.79	94.01	3.07	8.11	0.129	16.67	242.30
T ₈	3.83	93.80	3.89	8.09	0.132	19.83	252.13
T ₉	4.10	91.89	4.11	8.07	0.136	20.99	259.17
SE.m. ±	0.04	0.22	0.04	0.01	0.002	0.31	0.69
CD(p=0.05)	0.12	0.66	0.12	0.02	0.007	0.93	2.08

picking fruits using a hand refractometer. A drop of juice extracted from 5 g of macerated fresh sample was placed on the prism and readings were expressed in °Brix. Ascorbic acid content was determined volumetrically as per Rangana (1986). A 5 g fresh sample was macerated with 4% oxalic acid and 5 ml of filtrate was titrated against 2,6-dichlorophenol indophenol dye until a pink endpoint appeared. Results were expressed as mg ascorbic acid per 100 g edible portion. Moisture percentage was calculated by oven-drying known fresh weight samples at 60°C to constant weight, using the formula:

Moisture content (%) = $\frac{\text{Fresh weight (g)} - \text{Dry weight (g)}}{\text{Fresh weight (g)}} \times 100$

The data recorded for evaluation of different treatments in cucumber was statistically analyzed using standard procedure as suggested by Panse and Sukhatme (1985) for analysis of variance of RBD in order to test the significance of experimental findings.

Results and Discussion

Quality Parameters

The statistical analysis of findings revealed that the

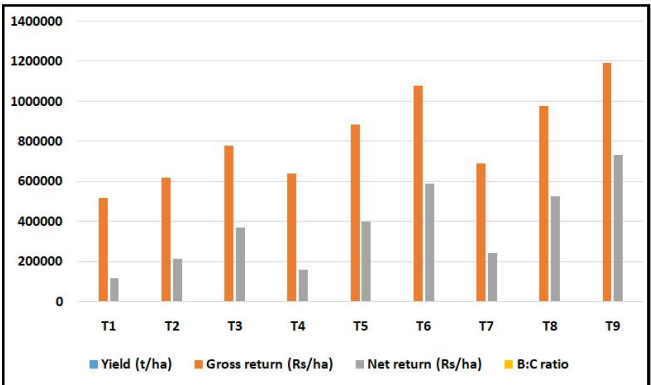


Fig. 2: Impact of Organic Amendments and NPK Fertilizers on Economics of Cucumber under Protected Cultivation.

combination of different organic manures and inorganic fertilizers significantly affected the quality of cucumber fruits like TSS, ascorbic acid and moisture content. Among all the treatments, the maximum total soluble solid (4.10°Brix) and ascorbic acid (4.11 mg/100g) with minimum moisture content in fruit (91.89%) was recorded with treatment T₉ (NPK - 100% + 10t/ha Wool waste) followed by T₆ (NPK - 100% + 10t/havermicompost) as depicted in (Table 2). As compare to other treatments in present investigation, fruits of cucumber in treatment T₁ (control) attained lowest quality in term of TSS and ascorbic acid which shows that inadequate supply of nutrients in the form of organic and inorganic fertilizers, deteriorates the quality of fruit, lower the amount of TSS and increase the moisture content and bitterness in the cucumber fruit. Similar findings were reported by Anjanappa *et al.*, (2012) in cucumber, Mashihet *al.* (2020) in bitter gourd and Choudhary *et al.*, (2024) in cucumber.

Soil Parameters

During the investigation, the effect of inorganic fertilizers combined management practices on soil fertility

Table 3: Impact of Organic Amendments and NPK Fertilizers on Economics of Cucumber under Protected Cultivation.

Treat-ments	Yield (t/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T ₁	26.00	520000	120000	1.30
T ₂	31.00	620000	215950	1.53
T ₃	39.00	780000	371900	1.91
T ₄	32.00	640000	160000	1.33
T ₅	44.30	886000	401950	1.83
T ₆	54.00	1080000	591900	2.21
T ₇	34.63	692600	242600	1.53
T ₈	49.00	980000	525950	2.15
T ₉	59.70	1192000	733900	2.60

status, *i.e.*, soil pH, organic carbon content (%), available P_2O_5 (kg/ha), and available K_2O (kg/ha) after harvest were found to be significant. Among all the treatments, the maximum organic carbon (0.136 %), available P_2O_5 (20.99 kg/ha) and available K_2O (259.17 kg/ha) with lower soil pH (8.07) was recorded with treatment T_9 [NPK - 100% + 10t/ha wool waste] as compare to T_1 (control). The data relevant to soil is presented in (Table 2). This might be due to the fact that the NPK content in wool waste was higher and soli microbes broke down organic matter and produced organic acids and these acids had broken down nutrient containing compounds into available forms that can be used by the plants. Integration of organic and inorganic fertilizers might have resulted in improved soil physical, chemical and biological properties thereby maintaining the efficient supply of nutrients and wool waste also breaks down cations of calcium and magnesium that can help to neutralize soil pH. These findings are in line with Sharma *et al.*, (2017) in okra, Barik *et al.*, (2018) in ridge gourd Singh and Tiwari (2019) in okra.

Economics of Treatments

The economics of crop production under polyhouse is a very important part of cultivation. Higher profits and less cultivation cost are advantageous traits for getting higher returns. Economic is the need of the hour for the farmers while tacking a decision regarding the adoption of a new techniques. The highest benefit-cost ratio (2.60) was observed in the treatment T_9 (NPK - 100% + 10t/ha wool waste) with higher net return (733900 Rs/ha) and the lowest benefit-cost ratio (1.30) with lowest net return (Rs.120000) was recorded in the treatment control. The data relevant to B:C ratio and net return is presented in (Table 3). The findings were supported by Kumar *et al.*, (2017) in cucumber, Nagar *et al.* (2017) in bottle gourd and Pathak *et al.*, (2022) in bottle gourd.

Conclusion

The present study clearly demonstrates that the integrated application of organic and inorganic nutrient sources has a significant impact on improving soil health, enhancing fruit quality and increasing the profitability of cucumber cultivation under protected conditions. Among all the treatments, the treatment NPK - 100% + 10t/ha Wool waste(T_9) emerged as the most effective, leading to improvements in key soil parameters such as organic carbon content and available NPK, while also enhancing quality traits like TSS, ascorbic acid content and fruit size.

Economically, T_9 recorded the highest net returns and benefit-cost ratio, indicating that balanced nutrient

management not only improves sustainability but also ensures better financial outcomes for growers. The inclusion of wool waste, an agro-industrial byproduct, in the nutrient management regime adds further value by promoting waste recycling and reducing dependency on chemical fertilizers.

Overall, the study advocates for the adoption of integrated nutrient management practices involving a strategic mix of vermicompost, wool waste and NPK for sustainable cucumber production under protected cultivation. This approach not only conserves soil fertility and reduces environmental risks but also enhances the economic viability of protected farming systems, making it a suitable model for small and medium-scale vegetable growers.

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