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Research Article

Comparison Of Nutritive Values Due To Impact Of Controlled Environment And Fertilizer Application On Vegetable Crops

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ABSTRACT

Polyhouse cultivation, with its ability to provide controlled environmental conditions, presents a promising avenue for optimizing the growth and nutritional quality of vegetable crops. This research project delves into the effects of controlled environmental conditions and specific fertilizer applications on the nutritional composition of various vegetable crops within a polyhouse setting. In the pursuit of sustainable agriculture, minimizing the use of chemical fertilizers is paramount for ensuring the safety of crop production. To address this, our research investigates the combined impact of bio and chemical fertilizers. We explore four fertilizer combinations: 100% irrigation with no fertilizer, 100% bio fertilizer (consisting of coco peat, mushroom compost, cow dung, bone waste, and bone marrow waste at 100g), a blend of 75% bio fertilizer (75g) and 25% chemical fertilizer (DAP di-ammonium phosphate granules), and an equal mix of 50g bio fertilizer and chemical fertilizer. Prior to field preparation, meticulous spacing calculations were performed, resulting in the cultivation of a 75 sq. m area with 16 meticulously prepared seed beds. The seed beds are formed in such a way that they are raised to a height of 0.3m and the upper face of a bed is of dimension 2.29 m and the base length is of 2.4m and the base breadth is of 1.2m. This research is taken place under protected cultivation (polyhouse) where the vegetable crops such as Tomato, Cauliflower, Brinjal and Cabbage are been cultivated. The nutritive value of the vegetable crops was compared for all the mentioned combinations thereby determining the efficiency of each combination.

Key words - Chemical fertilizer, bio fertilizer, protected cultivation, nutritive values, DAP di-ammonium phosphate, mushroom compost, bone waste.

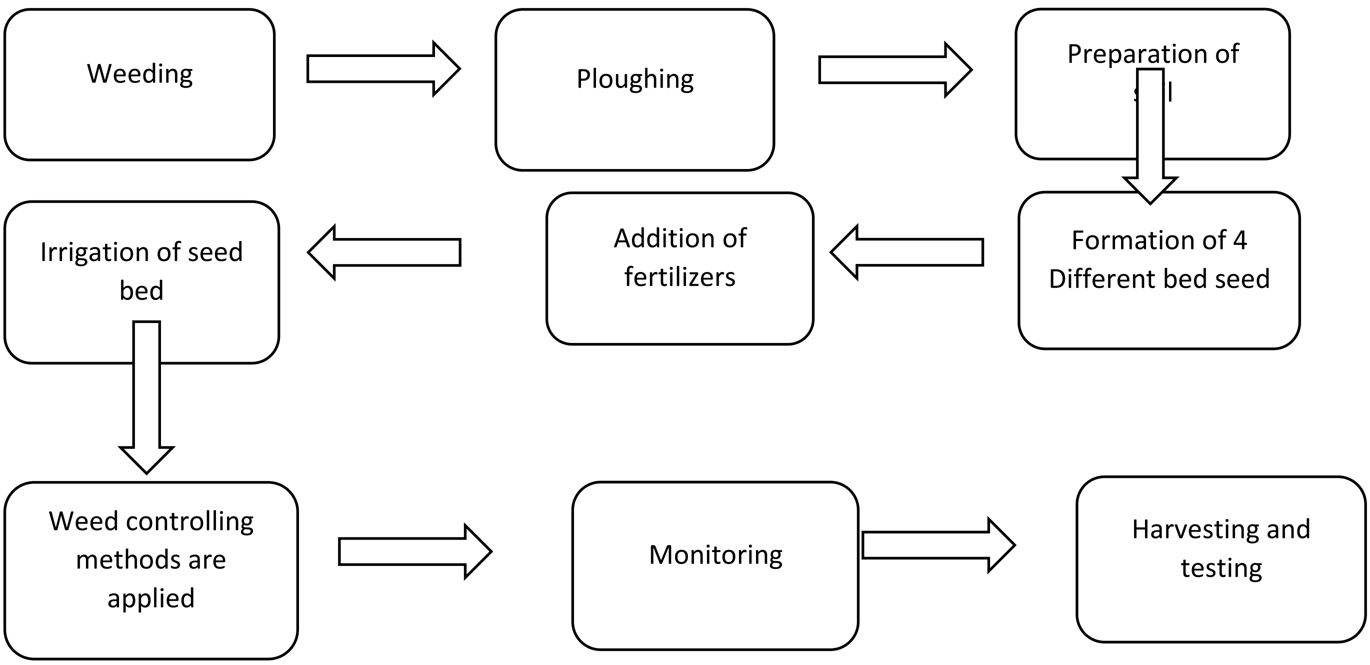
INTRODUCTION

A study in polyhouse is found that on average, fertilizer application improved crop yield by 30.9% and nutritional quality by 11.9%. Desirable climatic conditions and soil properties supported further enhancements.[1] This review examines the variation in nitrogen and phosphorus (N) and phosphorus (P) availability in terrestrial plants, focusing on their impact on vegetation composition and functioning.[2] A compound fertilizer (N:P:K:O,18:7:20) was adopted for topdressing at four levels, 1290kg/ha, 1140kg/ha, 990kg/ha, and 840kg/ha, with the locally recommended level of 1875kg/ha used as the control. The fertilizer rate at 840kg/ha has not only maintained the productivity of soil but also tomato growth and quality of fruit, making non-pressure gravity irrigation a potential and cost-effective way for fertilizer application.[3]
The compounded harmful effects of imbalanced fertilizer use are intensifying soil and atmospheric pollution, impacting water bodies, and threatening biodiversity and human health. This has led to harmful effects such as soil and atmospheric pollution, eutrophication, threats to biodiversity, and the formation and release of nitrous oxide (N_2O), a harmful greenhouse gas.[4] The investigation of the effects of biofertilizers and organic fertilizers on reducing consumption and improving the effectiveness of chemical fertilizer treatments in lettuce and broccoli grown under greenhouse conditions.[5]

The impact of different levels of organic and inorganic fertilizers on the growth, yield, and quality of Brinjal, a staple vegetable in India. The results showed that the application of nutrients through a combination of organic manure and inorganic fertilizers was beneficial for increasing the growth of the brinjal crop.[6] The fruit and yield parameters, such as average fruit weight, length of fruit, diameter of fruit, fruit per plot, fruit per plant, and fruit per hectare, were significantly influenced by the combination of organic and inorganic fertilizers in different treatments.[7]
With advancements in agriculture, several protected cultivation practices have been adopted in commercial farming, such as greenhouses, plastic houses, internet houses, and shade houses. The study aims to improve nutrient management in protected cultivation to mitigate the negative effects of climate change on crop growth and development.[8] This research investigates the effects of organic and inorganic fertilizer application on rice growth, yield, and grain quality. The study focuses on the traditional application rate of nitrogen and phosphorus (RD), animal manure (AM), animal manure with 50% nitrogen and phosphorus (AMRD), sawdust (SD), and sawdust with 50% nitrogen and phosphorus (SDRD).[9] The study found that dissipation is slower in polyhouse compared to open fields due to various factors. The study suggests that in polyhouse and open field PHI of 7 days and 5 days can be recommended as the residues degraded to BDL by the 10th and 7th day.[10]
Polyhouses are used for growing various plants, such as flowers, vegetables, fruits, and tobacco. A conventional chat has been integrated with the GUI to add vibrancy to inter-user communication. This feature can be embedded in upcoming 3G mobile technology.[11] Polyhouses are generally built up using bamboos or pipes made of iron material to cover the surroundings with ultra violet plastic sheets. Parameters like temperature, humidity, CO2 levels, soil pH, soil moisture content, and water level play an important role for plant growth.[12]

METHODOLOGY

The methods involved in Process of crop production are mentioned below as a flow chart:



About 70% of the Indian population practices agriculture. Hence, the production and management of crops is an important aspect to ensure optimal productivity in the fields. The major agricultural practices involved in crop production and management are listed below:

- Preparation of Soil
- Sowing of Seeds or transplanting
- Addition of Manure and Fertilizers
- Irrigation
- Monitoring
- Harvesting

Preparation of Soil

Before the seeds are sown, the soil is slanted and made loose. For this aim, ploughs are employed. Large lumps in the soil are broken up using a hoe to help break them up. This procedure aerates the soil, facilitating easy breathing for the roots. After being thoroughly combined with the soil, the minerals and nutrients rise to the surface. Consequently, the soil becomes more fertile and suitable for planting. The main purpose of spraying Glycel, a popular herbicide, inside the polyhouse grounds is to get rid of any common weeds that can interfere with the experiment. To effectively dry out the weeds, the plot is left undisturbed for a period of twelve days. Further, the ploughing process is carried out on the land until the soil turns to a fine tilth.

Sowing of Seeds or transplanting

The good quality, infection-free seeds are collected and sown on then Traditional techniques prepared land. The seeds should be sown at proper depths and proper distances. Following are the various methods used to sow the seeds:

- Broadcasting
- Dibbling
- Drilling
- Seed dropping behind the plough
- Transplanting
- Hill dropping
- Traditional technique

Addition of Manures and Fertilizer

The soil may not have the right nutrients to efficiently sustain plant growth. Hence, manures and fertilizers are added to the soil to increase its fertility and help plants grow better. Manure is prepared by using decomposing plant and animal matter in compost pits. After the land preparation, the land is wetted to a stage such that holes can be made for the tomato seedlings to be transplanted. Holes of 2 inches are made in the ground following the layout pattern. Now, fertilizers are administered as per the predetermined combinations and quantities inside the holes. The predetermined quantities and varieties of fertilizers are applied.

Irrigation

Crops require water at regular intervals for proper growth. The supply of water to the plants is known as irrigation. Well, rivers, lakes, tube-wells are different sources for irrigation. The traditional methods of agriculture involve the use of humans and animals. The various traditional ways are moats, chain-pump, dhekli, rahat. Now, a drip irrigation system is laid such that the emitters drip water as close to the root of each individual plant as possible. The volume of water that is received by the plants are also predetermined and varies from treatment to treatment. Hence, the discharge from each emitter needs to be measured and the setup needs to be calibrated accordingly.

Monitoring

The undesirable plants that grow along with the crops are called weeds. These weeds, feed on the nutrients provided to the crops and thus reduce the supply of nutrients to the crops, thereby, inhibiting their growth. The growth of these weeds needs to be prevented in order to enhance the growth of the plants. The process of removal of weeds is called weeding. Weedicides are employed, which are essentially chemicals specifically made to destroy weeds. They are usually sprayed before seeding and flowering.

Harvesting

Once the crop is matured or fully ripen, they are cut and gathered (Reaping) which are collectively called as harvesting. Harvesting depends on many factors like season, crop variety, maturity period, etc. Over irrigation, irregular sunlight can prolong ripening of crop which thus delays the harvesting time.

Irrigation chart

This feat is achieved through the adjustment of gate valves attached to each and every individual emitter. The water to be irrigated is split into recommended volume (0.50 litre plant-1 day-1), 50% of the recommended volume (0.25 litre plant-1 day-1), 75% of the recommended volume (0.75 litre plant^{-1} day^{-1}) and 100% of the recommended volume (1 litre plant-1 day-1) are administered to the crops of the respective treatment beds.

TREATMENTS	VOLUME OF WATER
Treatment-1	0.25 litre plant-1 day-1
Treatment-2	0.50 litre plant-1 day-1
Treatment-3	0.75 litre plant-1 day-1
Treatment-4	1 litre plant-1 day-1

Table 1. Irrigation chart

Fertilizer application

Fertilizers are applied manually over each bed. The required quantity of MOP and DAP are calculated per plant, weighed and then applied carefully over each bed. The quantity of fertilizers is split into recommended dosage, half the quantity of recommended dosage and area ministered to the respective treatment beds. Detailed chart of fertilizer application is mentioned in the above Table 2.

TREATMENTS	QUANTITY OF FERTILIZER
Treatment-1	No fertilizers
Treatment-2	100g of bio fertilizer
Treatment-3	75g of bio fertilizer + 25g of chemical fertilizer
Treatment-4	50g of bio fertilizer + 50g of chemical fertilizer

Table 2. Fertilizer ratio chart

Once all of the above processes are completed, the biometric characteristics of random plants are noted starting from the 7th day from the day of transplantation up to the 70th day. The biometric readings are noted regularly.

DESIGN OF EXPERIMENTAL SETUP

The experiment commenced by creating distinct beds for each treatment and their replications. The experimental layout is illustrated below, with each block representing a unique treatment featuring different vegetable crops.

Fig 1. Cropping Layout

The beds are formed in such a way that they are raised to a height of 0.3m and the upper face of a bed is of dimension 2.29 m. Each bed is surrounded by a path of 0.3m to freely access individual beds. The dimensions of a bed are depicted in the figures below.

Fig 2. Top view of the Seedbed

Following the formation of beds, robust seedlings were procured and transplanted into the beds. Each bed accommodates a total of 10 plants, with a spacing of 0.45 m between them. The transplantation process ensures that each plant is positioned with a distance of 0.15 m from the edges of the bed. The spacing details of the seedlings are depicted below, with each circle representing an individual seedling.

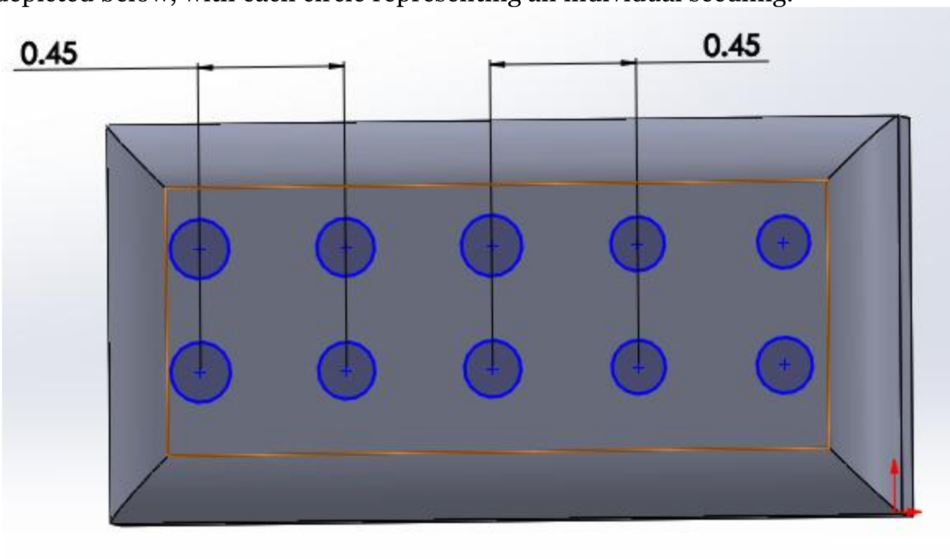


Fig 3. Plan view of the Seedbed

After transplantation, the crops undergo thorough manual irrigation for a period of 7 days, regardless of treatment, to mitigate transplantation shock and facilitate root establishment. Irrigation is conducted using a drip irrigation system, calibrated to deliver the necessary volume of water to the crops within a 15-minute duration.
Subsequently, fertilizers are manually applied to each bed, with the quantity of DAP carefully calculated per plant, weighed, and evenly distributed across the beds. The dosage is divided into recommended and half-recommended quantities, with the corresponding area of application specified in Table 2.
Following these procedures, biometric characteristics of selected plants are recorded from the 7th day post-transplantation until the 70th day. Regular biometric readings are documented and forwarded to the laboratory for nutritive analysis.

LITERATURE REVIEW

Many Researchers have done their research on comparison of nutritive values on vegetable crops in that some are as follows:
1.1 Muhammad Ishfaq1, Yongqi Wang: A global meta-analysis of 7859 data pairs from 551 field experiment-based articles published between 1972 and 2022 reveals that fertilizer application significantly improves the nutritional quality of food crops. The study found that on average, fertilizer application improved crop yield by 30.9% and nutritional quality by 11.9%. The improvements were largely nutrient- and crop species-dependent, with vegetables being the most responsive. Potassium, magnesium, and micronutrients played important roles in promoting crop nutritional quality, while the combined application of inorganic and organic sources had the greatest impact on quality. Desirable climatic conditions and soil properties supported

further enhancements. The findings pave the way towards a quantitative understanding of nutrient management programs and responsible plant nutrition solutions that foster the sustainable production of nutritious and healthy food crops for human consumption. Undernutrition, or lack of carbohydrates and micronutrient malnutrition, remains a persistent problem. Plants require at least fourteen mineral elements, and more than 20 are essential for human health. Biofortification of staple crops can be an effective strategy for combating malnutrition.

1.2 Jedvkeurf: This review examines the variation in nitrogen and phosphorus (N) and phosphorus (P) availability in terrestrial plants, focusing on their impact on vegetation composition and functioning. The study reveals that plastic responses of plants to N and P supply cause up to 50-fold variation in biomass N:P ratios, associated with differences in root allocation, nutrient uptake, biomass turnover, and reproductive output. At the vegetation level, N:P ratios often correlate negatively with biomass production, with high ratios promoting graminoids and stress tolerates relative to other species. Using N:P ratios of plant biomass as indicators of N or P limitation, various studies suggest that shifts in limitation lead to changes in plant traits, vegetation composition, and species diversity. Plant N:P ratios have been used to describe functional differences between naturally nitrogen- or nitrogen-limited plant communities and their responses to environmental change or human management.

1.3 Qing-Jie Du, Huai-Juan Xiao (2021) This study aimed to select the optimal fertilizer application under specific irrigation levels and provide a reliable fertigation system for tomato plants. An experiment was conducted using a microporous membrane for water-fertilizer integration under non-pressure gravity. A compound fertilizer (N:P:K:O,18:7:20) was adopted for topdressing at four levels, 1290kg/ha, 1140kg/ha, 990kg/ha, and 840kg/ha, with the locally recommended level of 1875kg/ha used as the control. The new regime of microporous membrane water-fertilizer integration under non-pressure gravity irrigation reduced the fertilizer application rate while promoting plant growth in the early and intermediate test ages. Except for the 990kg/ha fertilizer treatment, yields per plant and per plot foreach fertilizer application rate was higher than or equal to those of the control. The new regime could effectively improve PFP and reduce soil nutrient enrichment. Fertilizer at 840kg/ha has not only maintained the productivity of soil but also tomato growth and quality of fruit, making it a potential and cost-effective way for fertilizer application. In conclusion, the fertilizer rate at 840kg/ha has not only maintained the productivity of soil but also tomato growth and quality of fruit, making non-pressure gravity irrigation a potential and cost-effective way for fertilizer application.

1.4 Arvind K sukhla, Sanjib Kumar Behere (2022): Fertilizer use in Indian agriculture is a significant concern, with India ranking second in the world and first among the South Asian Association of Regional Cooperation (SAARC) countries in terms of total fertilizer consumption. However, the average fertilizer application per hectare in India during 2019-20 was much below that in SAARC countries. Overuse or misuse of fertilizer nutrients and negligence in the application of secondary and micronutrients have led to lower utilization of applied nutrients, causing environmental degradation and climate change. The compounded harmful effects of imbalanced fertilizer use are intensifying soil and atmospheric pollution, impacting water bodies, and threatening biodiversity and human health. The increased use of fertilizer-N has direct bearing on higher total nitrogen emissions and low nitrogen use efficiency (15-30%). This has led to harmful effects such as soil and atmospheric pollution, eutrophication, threats to biodiversity, and the formation and release of nitrous oxide (N2O), a harmful greenhouse gas. The fertilizer manufacturing industry in India is the second most important core sector after the steel industry.

1.5 Halil Demir 1, ˙Ilker Sönmez 2 (2023): The study investigates the effects of biofertilizers and organic fertilizers on reducing consumption and improving the effectiveness of chemical fertilizer treatments in lettuce and broccoli grown under greenhouse conditions. The biofertilizer (BM-MegaFlu®) comprised Bacillus megaterium, Pseudomonas fluorescens, and Pantoea agglomeransbacteria. The experiment consisted of six treatments, including biofertilizer (BF), chemical fertilizer + biofertilizer (CF + BF), chemical fertilizer (CF), CF (1/2 dose) + BF, CF (1/3 dose) + BF, and organic fertilizer (OF + BF). The biofertilizer had a supportive effect on the use of chemical fertilizers in lettuce and broccoli production, especially the CF (1/2) + BF treatment in lettuce. The CF (1/2) + BF and CF (1/3) + BF treatments in broccoli showed similar yields to CF. In both crops, BF could provide 50% chemical fertilizer savings. The study highlights the importance of biofertilizers in enhancing plant growth, yield, and mineral concentration in lettuce and broccoli. Biofertilizers, which contain living microorganisms, can be used to reduce these problems. Biofertilizers colonize the rhizosphere and increase the uptake of plant nutrients, making them environmentally friendly and providing plants with access to nutrients according to chemical or organic fertilizers. This research aimed to determine the effects of biofertilizer applications on the yield, quality, and mineral concentrations in lettuce and broccoli in greenhouse conditions and whether it will reduce the use of chemical fertilizers.

1.6 Munish Palia1, S. Saravanan: The study investigates the impact of different levels of organic and inorganic fertilizers on the growth, yield, and quality of Brinjal (Solanum melongena L.), a staple vegetable in India. The results showed that the application of nutrients through a combination of organic manure and inorganic fertilizers was beneficial for increasing the growth of the brinjal crop. The study conducted at the Horticulture Experimental field at the Department of Horticulture, Naini Agriculture Institute, Sam Higgin Bottom University of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India, aimed to investigate the effects of different levels of organic and inorganic fertilizers on the growth, yield, and quality of Brinjal (Solanum melongena L.). The experiment involved different treatments, such as 75% RDF + 20 tonnes Farm Yard Manure, 5 tonnes Poultry Manure, and 10 tonnes Farm Yard Manure. The study also revealed that the higher the levels of organic manures and inorganic fertilizer, the higher the yield and fruit parameters of Brinjal. The results suggest that the use of different fertilizers can significantly impact the growth, yield, and quality of Brinjal.

1.7 Muhammad Yasir Naeem, Senay Ugur (2020): The study investigates the impact of different levels of organic and inorganic fertilizers on the growth, yield, and quality of Brinjal (Solanum melongena L.), a staple vegetable in India. Brinjal is a member of the solanacea family and is popular among both the poor and rich. Its nutritive value varies among varieties, with vitamin A and B being common. Brinjal may have medicinal properties, like white brinjal used for diabetic patients. The study aims to investigate the intergraded management of yield and yield-contributing characteristics of brinjal and soil properties.An experiment was conducted at the Horticulture Experimental field Department of Horticulture, Naini Agriculture Institute, SHUATS, Allahabad during the Rabi season of 2016-17. The results showed that the application of nutrients through a combination of organic manure and inorganic fertilizers was beneficial for increasing the growth of the brinjal crop. The fruit and yield parameters, such as average fruit weight, length of fruit, diameter of fruit, fruit per plot, fruit per plant, and fruit per hectare, were significantly influenced by the combination of organic and inorganic fertilizers in different treatments.

1.8 Naveen Kumar, Gagandeep Singh (2015): Brinjal, a popular vegetable crop, is a rich source of antioxidants, minerals, and vitamins. However, due to high insect-pest incidence, it is difficult to grow this crop without using pesticides. Protected cultivation of brinjal crop can be a promising technology to minimize the use of chemicals and provide better quality fruits. Parthenocarpy in brinjal can be used to grow successful crops, as the development of partheoncarpic fruits does not require pollination. Sharapova and Fantastic are among the F 1 hybrids that can be grown successfully in protected structures like walk-in tunnels and naturally ventilated polyhouses. In parthenocarpic hybrids, seedlings are crucial for germination and can be produced in a protected environment using soil-less media. This medium consists of cocopeat, perlite, and vermiculite, with cocopeat being made from coconut husk waste in India, vermiculite being heat expanded mica, and perlite being heat expanded aluminium silicate rocks. The mixture is filled in pro-trays and seeds are carefully placed. For transplanting in August, seeds should be sown in mid-July. Germination takes 6-8 days, and a spray of N:P:K and Calcium nitrate is applied at 8-18 days. Training and pruning are essential cultural operations in protected cultivation, as the crop needs proper aeration.

1.9 Mohd Wamiq,Amit Kumar (2022): Protected cultivation is a cropping technique where controlled micro-climate influences plant growth and development. With advancements in agriculture, several protected cultivation practices have been adopted in commercial farming, such as greenhouses, plastic houses, internet houses, and shade houses. These greenhouses are framed or inflated structures lined with clear or semi-transparent material that allow crops to grow under controlled conditions. The importance of protected cultivation is highlighted in this study, which discusses the role of climate change in influencing crop growth and development. The main underlying cause is anthropogenic factors such as unsustainable use of fossil fuels, forest degradation for industrialization, and rapid urbanization with overpopulation. The study aims to improve nutrient management in protected cultivation to mitigate the negative effects of climate change on crop growth and development.

1.10 Sulata Khadka,Raj k Adhikari (2021): A study was conducted in October 2019 to compare the economics of tomato production under polyhouse and open field conditions in three different municipalities of Dhading district, Nepal. A total of 80 tomato growers, 40 from each production system, were selected randomly for the study. Data were collected through face-to-face interviews using semi-structured questionnaires. The estimated cost of production of tomato per ropani in open field farming was Rs 19955.75, while in polyhouse farming, it was Rs 58791.01. The gross return per ropani of tomatoes in open field farming was Rs 42623.21, which is less than that of tunnel farming. The BCR was higher in polyhouse farming (2.28) compared to open field (2.06). Labor cost was found to be the highest contributor in both the production system, while seed cost, machinery, and bullock cost were significant contributors in open field conditions. This study focuses on the profitability of tomato production systems in various rural areas of Nepal. A list of tomato producers was prepared from a farmer group's membership list, with 40 growers adopting plastic tunnels and 40 growers growing tomatoes in open fields. Primary information was collected through questionnaires and interviews. The study uses gross margin and net profit to determine profitability levels for both systems. The benefit cost ratio measures the project's worth. Both open field and tunnel tomato producers face problems, which are ranked using an index. The intensity of these problems is computed using a formula. The Cobb-Douglas production function was used to determine the contribution of different inputs and estimate the efficiency of variable production input in the two systems. The study aims to improve tomato production systems in these areas.

1.11 Zubair Noori et al.: This research investigates the effects of organic and inorganic fertilizer application on rice growth, yield, and grain quality. The study focuses on the traditional application rate of nitrogen and phosphorus (RD), animal manure (AM), animal manure with 50% nitrogen and phosphorus (AMRD), sawdust (SD), and sawdust with 50% nitrogen and phosphorus (SDRD) in Afghanistan. The study concludes that agrochemicals are a significant factor of pollution in developing countries and play a hazardous role in human and livestock health.

1.12 Ch. Sreenivasa Rao et al.: This investigates the dissipation pattern of lambda cyhalothrin on chilli in polyhouse and open field situations. Lambda cyhalothrin is a synthetic pyrethroid insecticide and acaricide commonly used against chewing and sucking insects, particularly lepidopterans and mites on chilli in India. In open fields, deposits of 0.16 mg kg-1 dissipated to BDL by the 7th day with a half-life of 34.65 days. The study found that dissipation is slower in polyhouse compared to open fields due to various factors. The study suggests that in polyhouse and open field PHI of 7 days and 5 days can be recommended as the residues degraded to BDL by the 10th and 7th day.

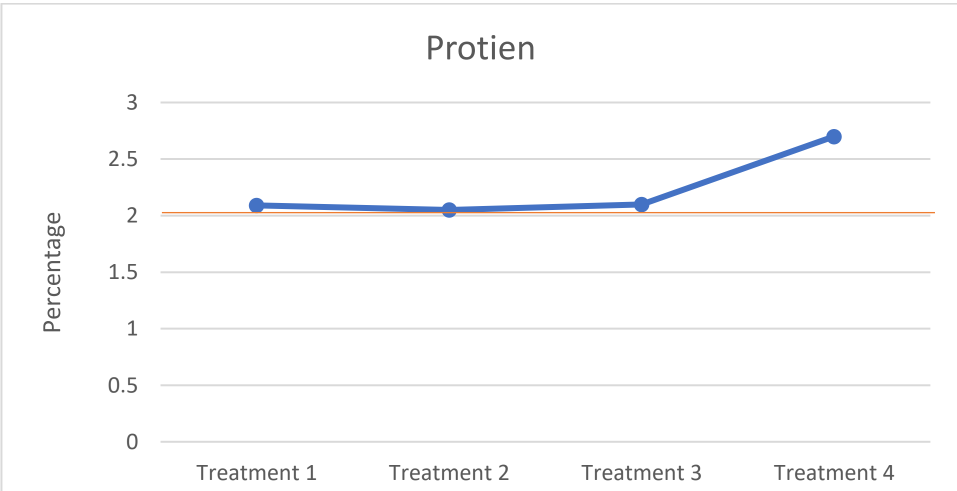
1.13 Vikas Sharma et al.: This study concluded that in India, agriculture is the main profession for most of the population, and a new approach called Polyhouse Cultivation is being developed to achieve good crops with less labor cost and less dependency on rainfall. Polyhouses are structures made up of polyethylene sheets, which are used to grow crops in a controlled environment even in unfavorable conditions. Polyhouses are generally built up using bamboos or pipes made of iron material to cover the surroundings with ultra violet plastic sheets. Parameters like temperature, humidity, CO_2 levels, soil pH, soil moisture content, and water level play an important role for plant growth. By sending data of various sensors through wired or wireless methods to a microcontroller-based system, desired atmospheric conditions can be maintained by using various output devices.

1.14 Yarong Zhang et al.: This reported that the study by Zhang et al. investigates the characteristics of greenhouse gas emissions from yellow paddy soils under long-term organic fertilizer application. The researchers found that organic fertilizer application increased CH_4 emissions from rice fields, and the effect increased with increasing organic fertilizer application. The peak period was from the heading stage to the filling and ripening stage, and there was almost no emission during the fallow period. The study suggests that organic fertilizer application can be an effective fertilization measure to reduce greenhouse gas emissions from yellow paddy fields.

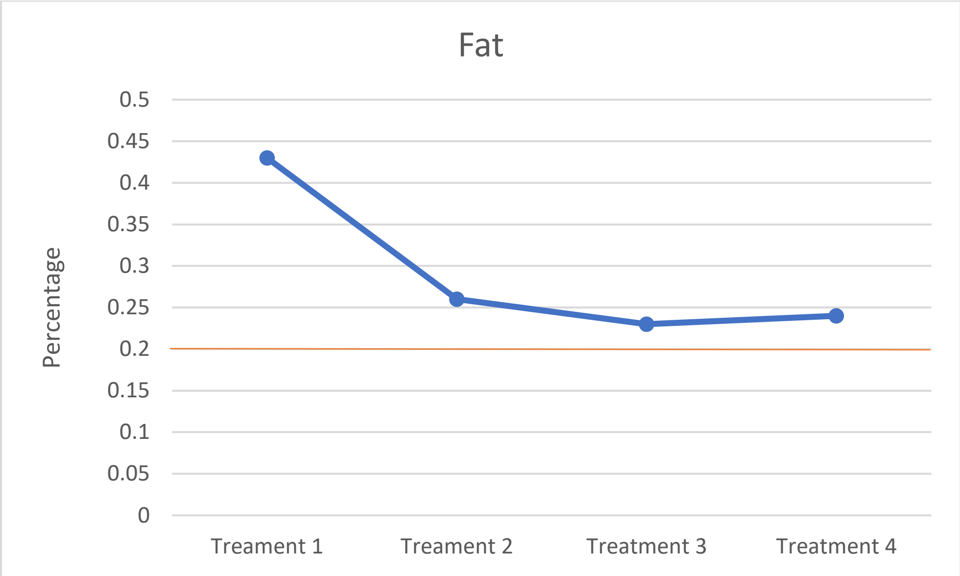
1.15 Raja G et al.: from the Department of Mechatronics Engineering investigated and explores smart polyhouse farming using IoT environment. Polyhouses are used for growing various plants, such as flowers, vegetables, fruits, and tobacco. A conventional chat has been integrated with the GUI to add vibrancy to inter-user communication. This feature can be embedded in upcoming 3G mobile technology. Simulations and video tutorials can also be integrated in the web server for teaching the farming community. Such integrated approach greatly widens the socio-economic possibilities for farmers through interaction with modern technological resources.

RESULT AND DISCURSION

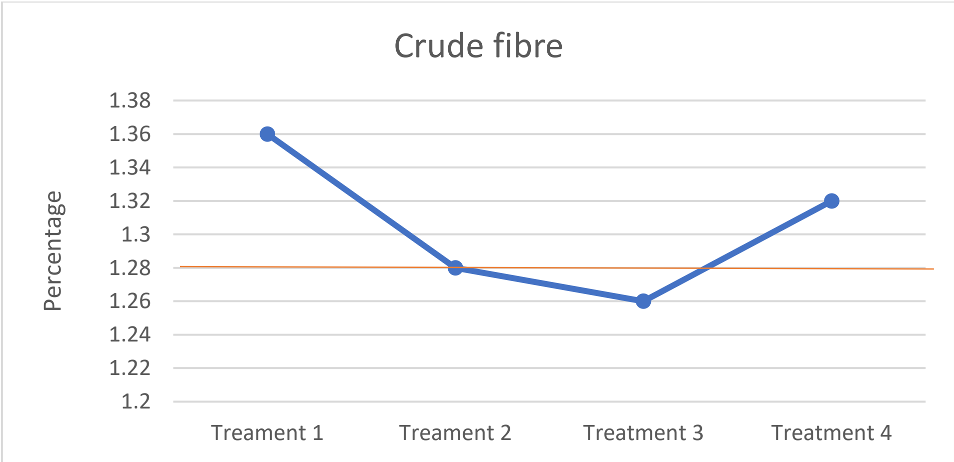
TOMATO NUTRITIVE TEST ANALYSIS – The various treatments application on tomato crops under protected cultivation are analysed and the graphical representations of the nutritive values are displayed below:



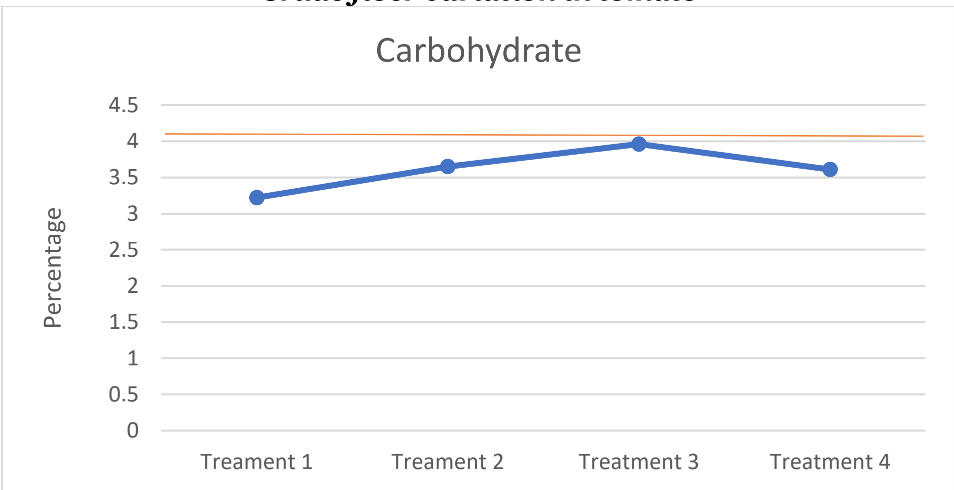
Protein variation in tomato



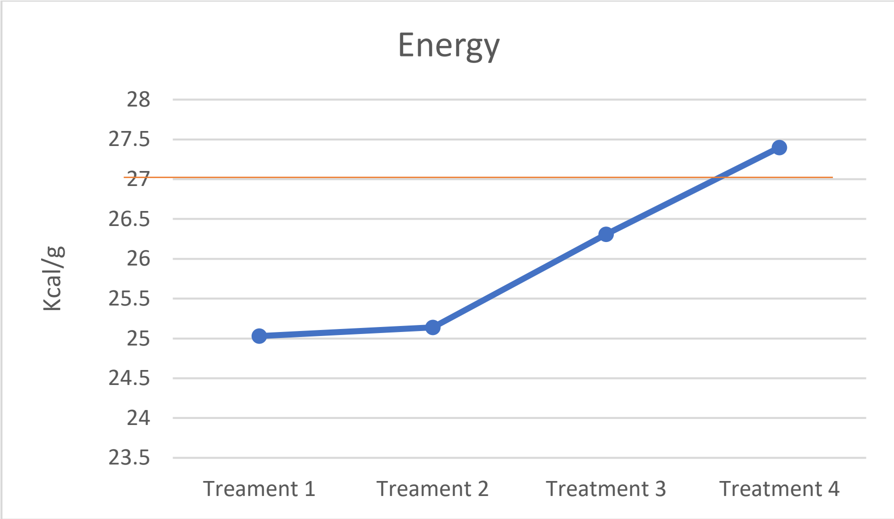
Fat variation in tomato



Crude fiber variation in tomato

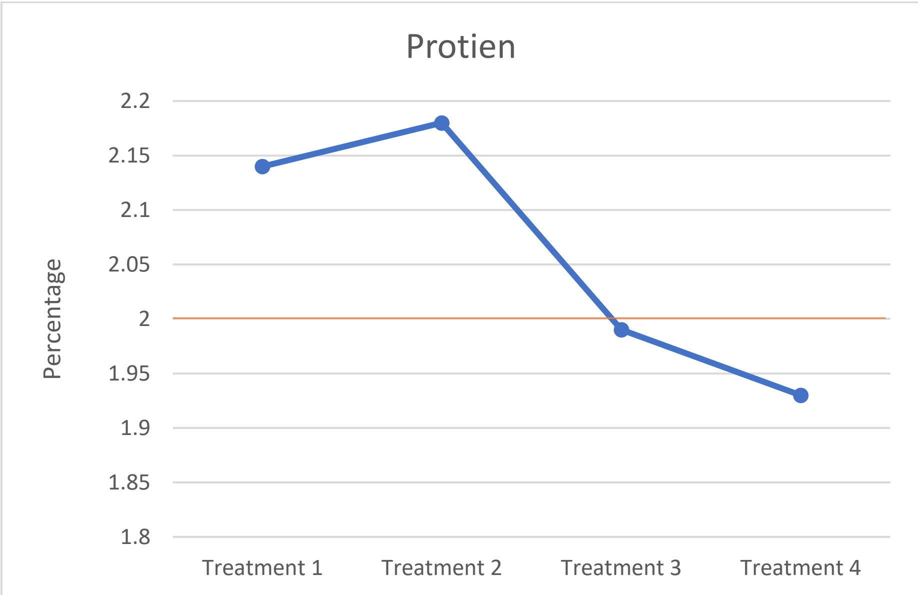


Carbohydrate variation in tomato

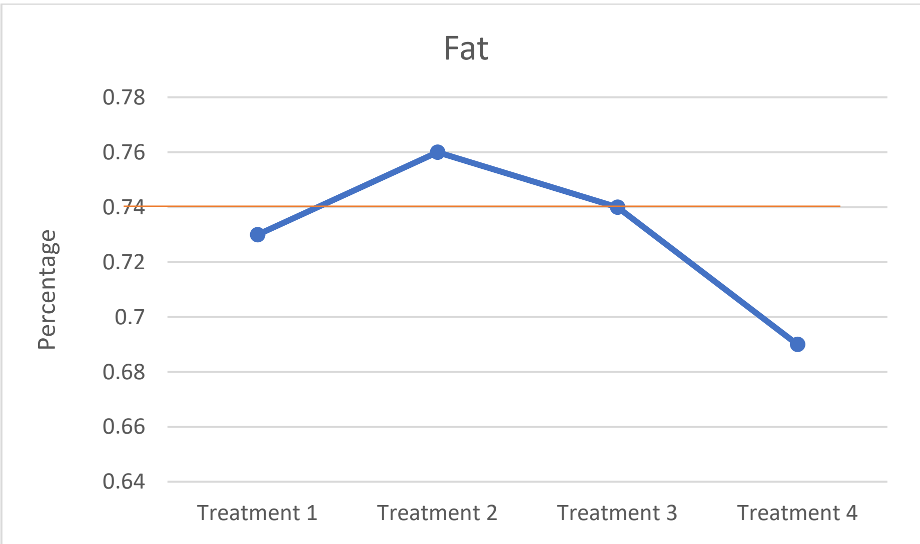


Energy variation in tomato

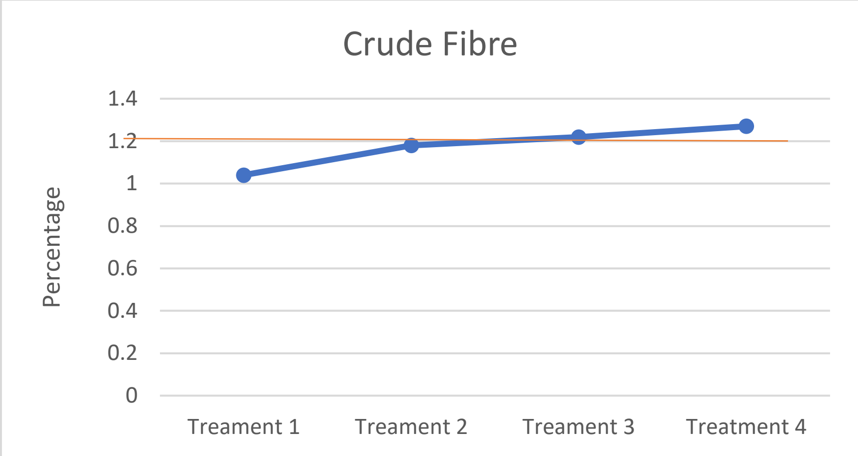
CAULIFLOWER NUTRITIVE TEST ANALYSIS – The various treatments application on cauliflower crops under protected cultivation are analysed and the graphical representations of the nutritive values are displayed below:



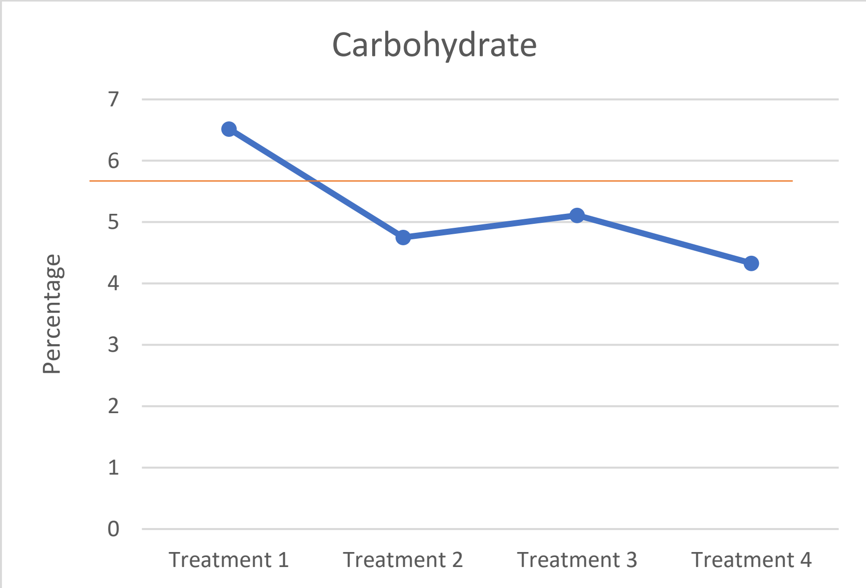
Protein variation in cauliflower



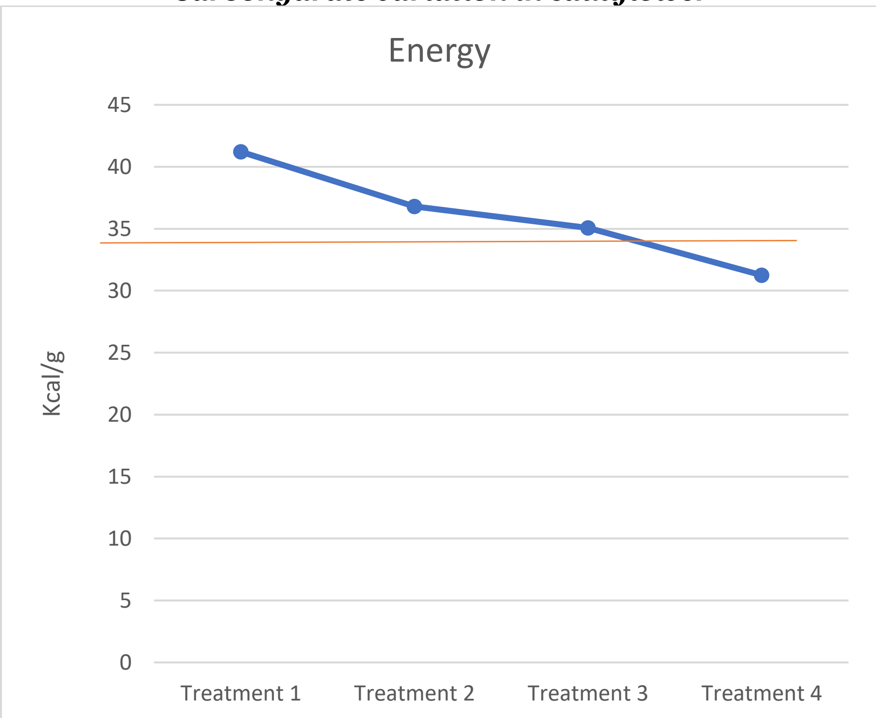
Fat variation in cauliflower



Crude fibre variation in cauliflower

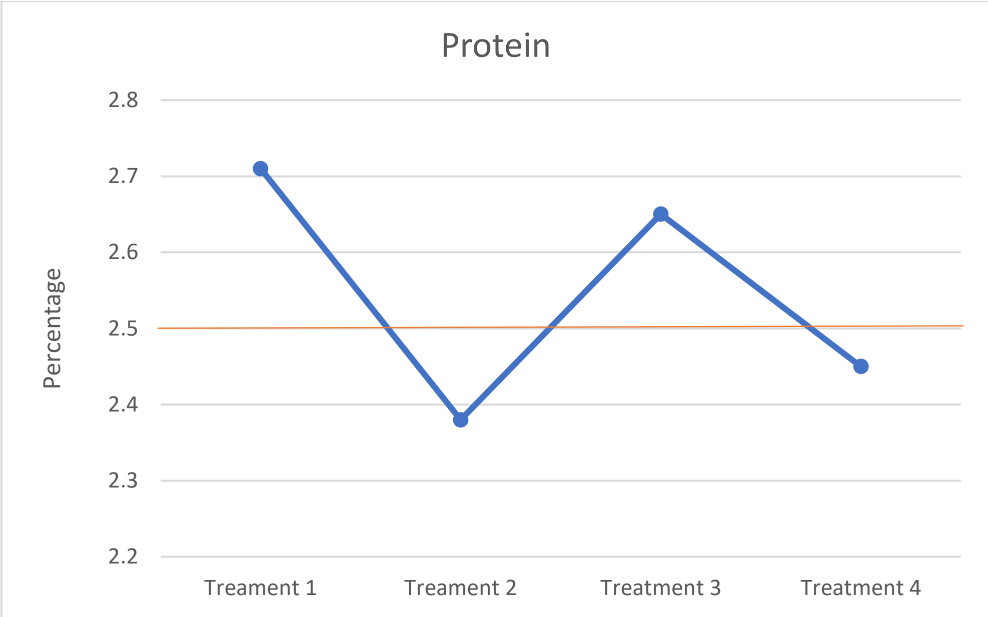


Carbohydrate variation in cauliflower

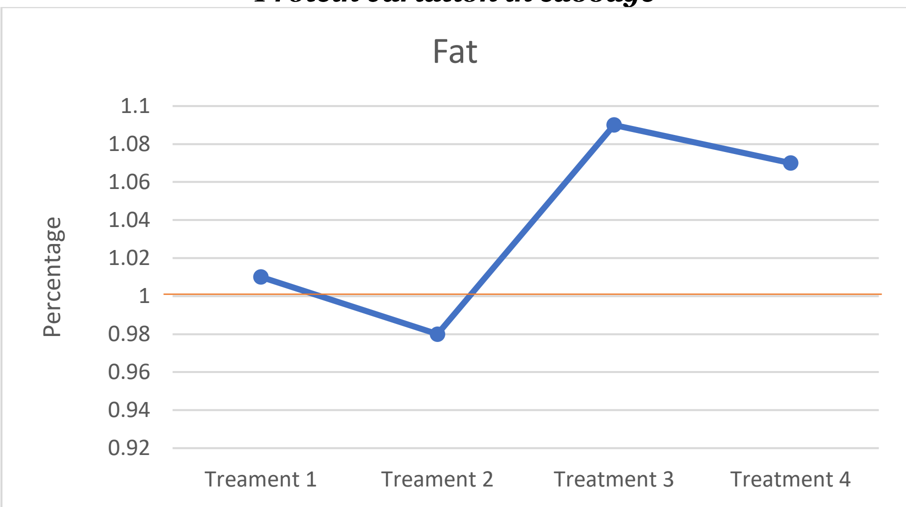


Energy variation in cauliflower

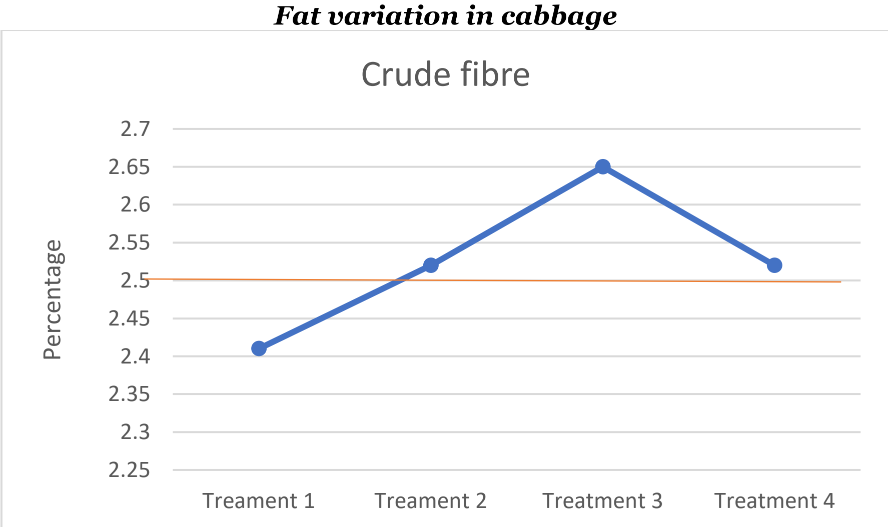
CABBAGE NUTRITIVE TEST ANALYSIS – The various treatments application on cabbage crops under protected cultivation are analysed and the graphical representations of the nutritive values are displayed below:



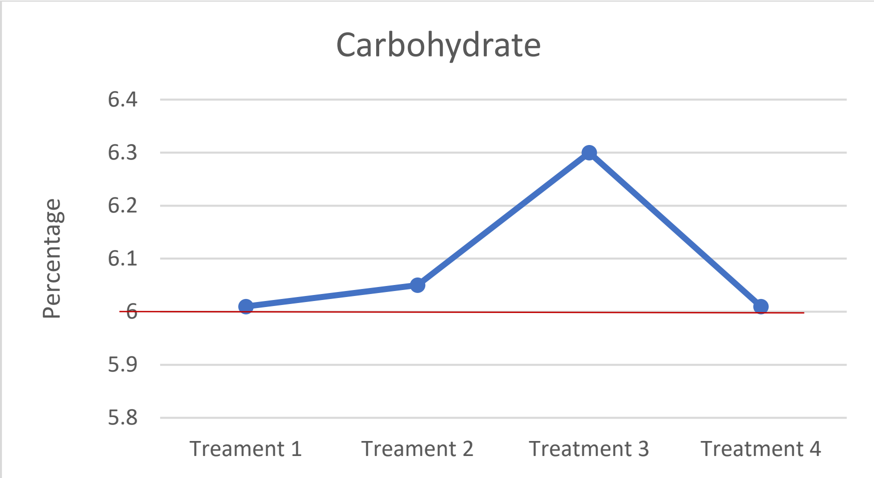
Protein variation in cabbage



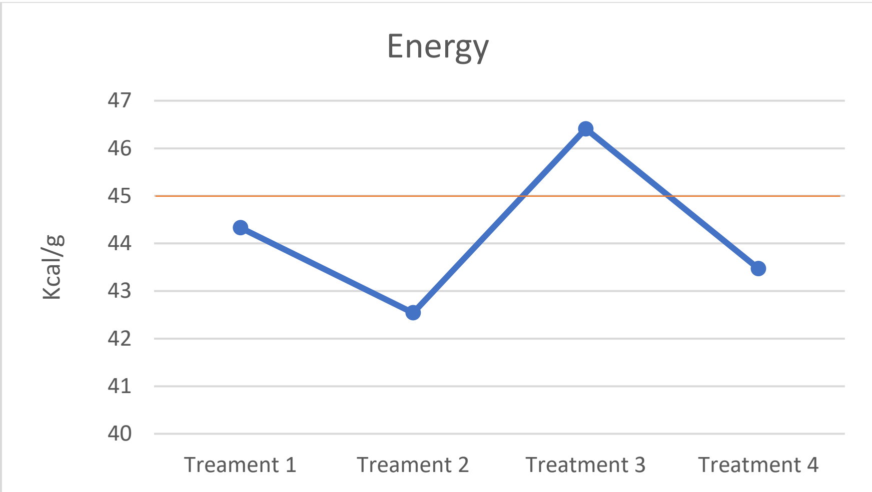
Fat variation in cabbage



Crude fibre variation in cabbage

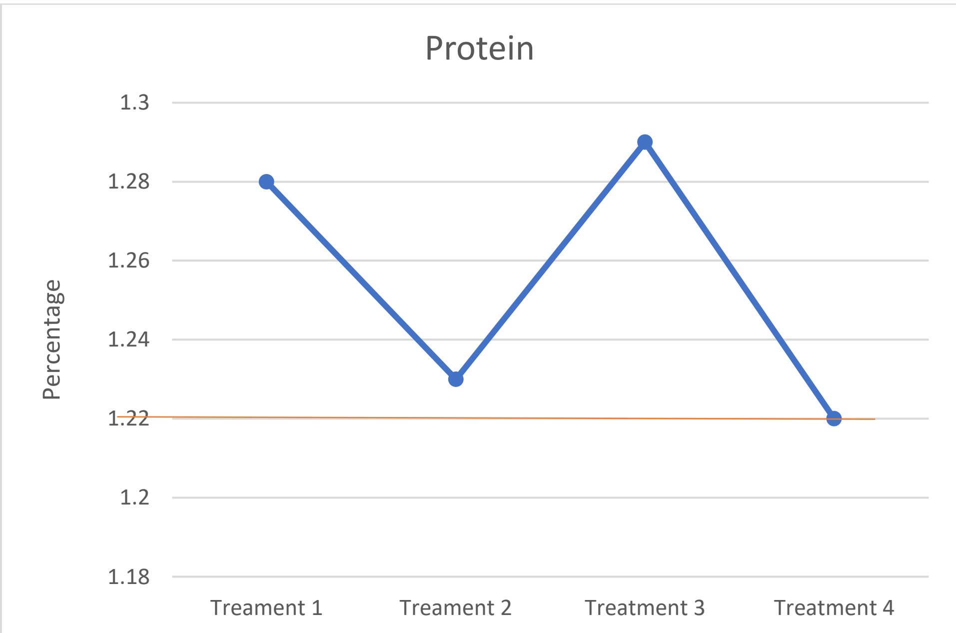


Carbohydrate variation in cabbage

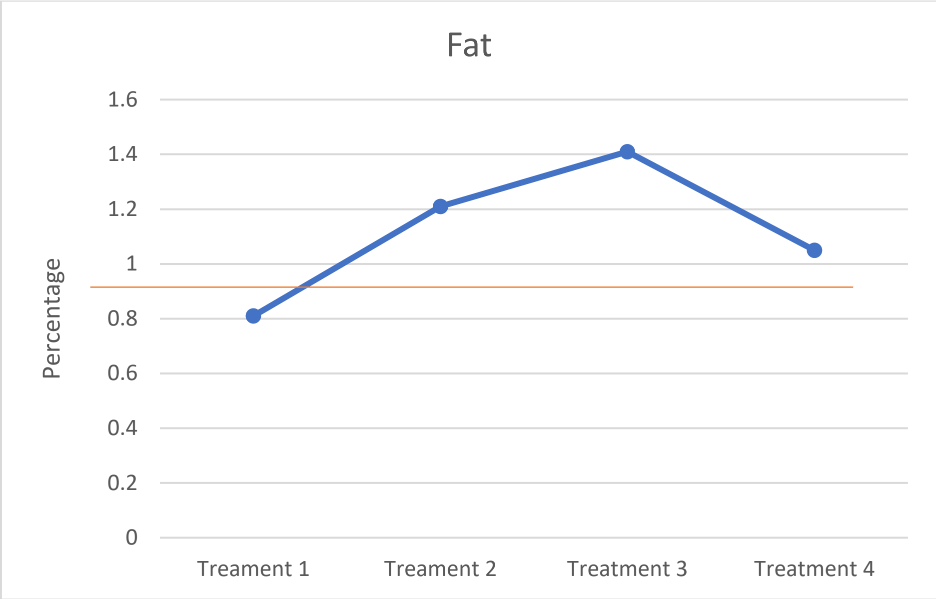


Energy variation in cabbage

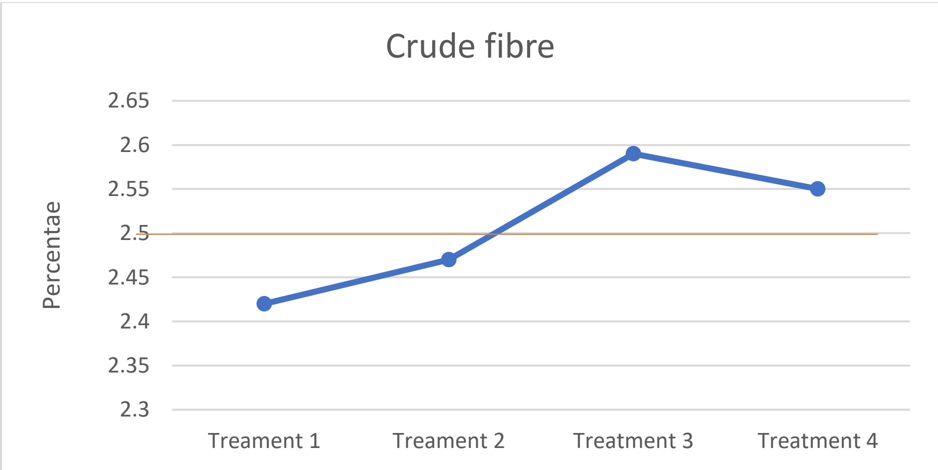
BRINJAL NUTRITIVE TEST ANALYSIS – The various treatments application on brinjal crops under protected cultivation are analysed and the graphical representations of the nutritive values are displayed below:



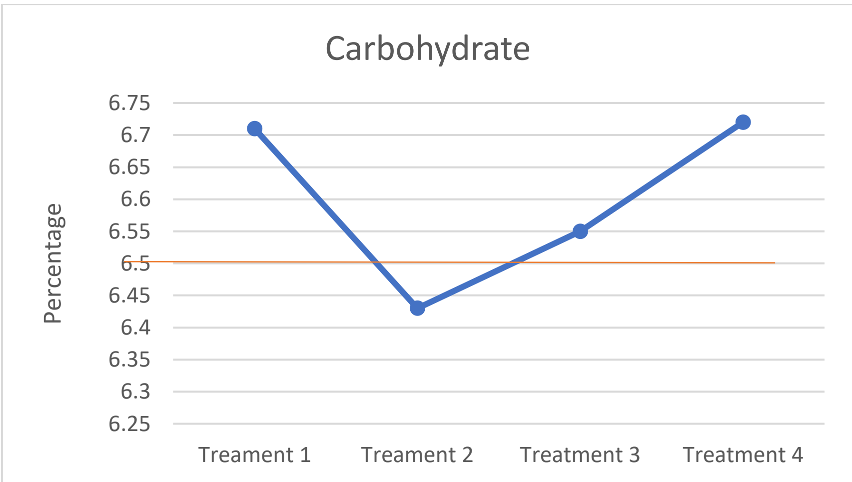
Protein variation in brinjal



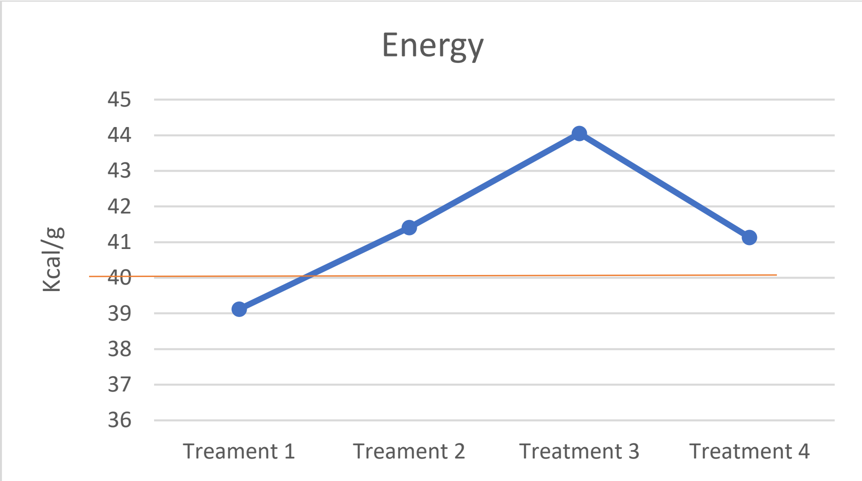
Fat variation in brinjal



Crude fiber variation in brinjal



Carbohydrate variation in brinjal



Energy variation in brinjal

CONCLUSION

In conclusion, the optimal growth, development, and nutritive value of vegetable crops can be achieved within a polyhouse environment. This is attributed to the precise administration of major nutrients (N, P, and K) via bio and chemical fertilizers, coupled with the consistent polyhouse temperature range (averaging between 31°C and 36°C) during the winter months from December to February. The controlled environment positively influences morphological, physiological, and phenological characteristics, mitigating the growth limitations typically experienced in cold winter conditions. By planting crops in a polyhouse, earlier maturity and superior crop stands are established compared to open field cultivation. Through rigorous biometric and nutritive analysis, treatment 3, comprising 75% bio fertilizer (75g) and 25% chemical fertilizer, emerged as the optimal combination, exhibiting superior phenotypic characteristics compared to other treatments. Graphical representations further confirm the efficacy of this combination, consolidating its status as the preferred choice for maximizing crop quality and yield within a polyhouse setting.

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