Efficacy of various organic and biofertilizer on the growth and yield of *Brassica oleracea L.* (Cabbage)

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Abstract: Organic manures and biofertilizers are widely renowned as effective all-encompassing approaches to improving soil quality. They utilise the benefits of organic components such as residual plant waste, compost, and manure. The incorporation of organic matter improves the structure of the soil, encourages microbial activity, and releases nutrients gradually. As a result, the study was carried out to evaluate whether organic manures were suitable for growing cabbage. This study adopted a randomised block design and included six treatments: vermicompost, poultry manure, farm yard manure, vermicompost + azotobacter, poultry manure + azotobacter and a control. The study assessed the cabbage's growth and yield characteristics, including height of the plant, number of leaves, head diameter, weight, and overall yield. The results of the study demonstrated that cabbage's growth and yield performance were significantly impacted by the application of organic manures. The highest production was obtained from the vermicompost +azotobacter treatment, which was followed by vermicompost and poultry +azotobacter. The use of organic manures led to considerable improvements in plant weight, height, and head diameter. In conclusion, the study provides useful knowledge on growing cabbage using organic manures. Farmers, legislative leaders, and various other agricultural sector decision-makers could employ the results of the investigation to promote profitable and sustainable cabbage growing techniques.

KEYWORDS: Plant Growth Parameters, yields, vermicompost, poultry manures, Organic Manures, Farm Yard Manures.

1.Introduction:

Cabbage (*Brassica oleracea var. capita L.)* is a common green leafy vegetable from the Brassicaceae family. This herbaceous, biennial, dicotyledonous flowering plant is characterized by a short stem topped with a pile of leaves, which are usually green but can also be red or purple in some forms. The leaves form a distinctive compact, globular cluster (cabbage head) when the leaves are still young. Cabbage has a moisture level of 60.6% and is a significant source of vitamin C. Additionally, it has calcium, potassium, and vitamin B complex.

Cabbage is a cold-weather crop that grows well in many soil types and temperatures, although colder climates with monthly temperatures between 13^0C-16^0C and well-fertilized soil provide the maximum yields. Productivity needs to be increased because it is low in India compared to other countries.

This is a sturdy vegetable that can withstand freezing and mild frosts. Though later varieties might require up to 120 days, early cultivars can usually be harvested in 70–90 days. Most kinds of cabbage may be grown as transplants or from seeds. In early spring, cabbage may be planted directly in the garden as soon as the soil is workable [1]. A good crop requires moist soil that has been mildly fertilised.

Asia Minor and Eastern Europe are the places where cabbage (*Brassica oleracea*) originated. It is relatively easy to grow and may be grew in many types of soil. It may be sown in the spring or the fall and thrives in colder climes. Sufficient watering, fertilisation, and defence against common pests are necessary for growing cabbage.

In recent years, the worldwide cabbage trade has changed dramatically. This overview uses the most recent data to give insights into the patterns, quantities, and trends that define the global movement of cabbage. In 2022, 9825000 tonnes of cabbage, or 232270 100 g/ha, were produced on 423000 hectares of land. India is a global exporter of cabbage, reaching every continent.

Analysing current statistics, some countries have regularly emerged as key contributors to cabbage exports China, which is recognized for its massive agricultural production, dominates the export market [2]. Other key contributors include the Netherlands, which is well-known for its horticultural prowess, and the United States, which is utilizing its agricultural capabilities.

India is the second-largest producer of cabbage in the world after China, where it is a popular annual crop. West Bengal, Orissa, Gujrat, Madhya Pradesh, Assam, Bihar, Chhattisgarh, Uttar Pradesh, Haryana, and Jharkhand are notable states that produce cabbage. West Bengal is the largest producer among them, accounting for roughly 24.38% of India's total output annually with an annual contribution of about 2,341.87 tonnes [3].

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Brassica oleracea contains a significant amount of antioxidants, which may help protect the body from free radical damage. Free radicals are unstable chemicals that can harm cells and tissues. Consuming cabbage lowers cancer risk and inflammation. The high concentration of phytochemicals in cabbage may be beneficial to health. Sulforaphane and indole-3-carbinol are two of them that may lower the risk of cancer and other illnesses. Additionally, cabbage is full of fibre, which helps maintain a healthy digestive tract. Reduced cholesterol and blood sugar management are two benefits of fibre. This might be beneficial for those who have diabetes.

In addition to being delicious, cabbage is a nutritional powerhouse. Cabbage contributes nutrition and balance to a diet since it is rich in minerals like calcium and potassium, as well as vitamins C, K, and other B vitamins [4,5,6]. Cabbage has several nutritional advantages that make it a valuable meal for improving overall health.

Chemical fertilisers deliver nutrients fast and in large quantities since they are made for certain nutrient formulations. Although they encourage quick growth and higher yields, questions have been raised about their possible long-term impacts on sustainability and the quality of the soil. The complex balance required for chemical fertilisation to guarantee optimal nutrient utilisation is examined [7]. Excessive use of fertilisers can cause the soil to become salted, decrease the availability of water, impede growth, and produce lower-quality crop [8].

Furthermore, as too much fertiliser can foster an environment that is conducive to the growth of pests and illnesses, overfertilizing cabbage may increase the burden of disease and pests. Moreover, chemical fertilisers frequently have short half-lives, which means that the nutrients swiftly seep out of the soil and are no longer accessible to the plant. This might cause the crop to become malnourished, which would hinder growth and lower production. In addition, incorrect application of chemical fertilisers can harm the ecosystem by letting the nutrients seep into adjacent water sources, increasing the phosphorus and nitrogen content of the water [9]. Algae can grow as a result of the eutrophication phenomena, which happens when water loses too much oxygen to sustain aquatic life [10].

Organic fertilizers are known for their all-encompassing approach to soil enrichment. They are derived from natural elements like as compost, manure, and plant leftovers. Adding organic matter improves the structure of the soil, encourages microbial activity, and releases nutrients gradually [11]. The benefits of organic fertilizers on microbial populations and soil health [12].

Organic farming produces superior cabbage than chemical cultivation for a number of reasons [13,14,15]. First of all, organic farming avoids the use of artificial pesticides, herbicides, and fertilisers which could be hazardous to the ecosystem or public health [16]. In addition to contaminating the land, water, and air, these pollutants increase the chance of developing health problems like cancer.

Furthermore, because organic farming employs fewer toxic chemicals, It encourages the use of helpful insects and organic thieves to manage pests and illnesses. An atmosphere that is healthier results from this. Lastly, because organic farming avoids the use of artificial fertilisers that can deplete the crops nutrient content, the crops nutritional value increases. Preserving biodiversity in the ecosystem is another benefit of organic farming. By using natural methods, organic farming promotes biological pest management and crop rotation, two activities that support the preservation of the environment's equilibrium in nature [17]. It is particularly advantageous to the cabbage as this encourages the development for beneficial insects and organic enemies, shielding the crop against pests and illnesses. Furthermore, because organic farming doesn't utilise Artificial fertiliser, that can deplete the nutrients in the soil and impair its structure, the soil is maintained.

Organic produce is frequently healthier. Synthetic fertilisers are not used in organic farming, which might lead to a product that is less nutritious. To further reduce the danger of disease and pest transmission, organic farming also uses crop rotation and organic pest management. This guarantees that the product is safe and free of harmful substances. Lastly, organic farming helps to maintain ecosystems. The elimination of synthetic fertilisers, herbicides, and pesticides significantly reduces the risk of contamination in the region. This reduces the likelihood of releasing pollutants into the air and water that might affect the ecosystem.

In addition, as organic farming encourages the application of natural methods, it is helps to reduce the amount of waste created. It reduces the amount of garbage produced. In conclusion, there are several reasons why organic farming is preferable to chemical cultivation of cabbage. Since organic farming doesn't use chemical fertilisers, herbicides, or pesticides, it is safer for the environment and the health of the general people. In addition, it helps preserve soil and climatic biodiversity and enables the production of healthier products. Finally, organic farming helps preserve the environment by reducing the danger of illness, waste and pollution production, and pest infestation.

The study on the effects of organic manures on cabbage yields and growth was directed for the cabbage growth and yield characteristics.

2. Material and methods:

The sustainable production of crops is the main focus of modern agriculture, which has led to a revaluation of conventional agricultural methods. The methodology and the materials utilised in this study have been carefully selected to ensure the validity of the findings. under experimental plots, a uniform variety of cabbage seedlings will be cultivated under strictly controlled environmental circumstances. Examples of organic manures that will be strategically applied at various stages of growth are compost, vermicompost, and farmyard manure. To prevent biases, the experimental design will employ randomised blocks, and the data collection will encompass a broad range of growth and yield-related parameters. The gathered data will undergo thorough statistical analysis, such as Analysis of Variance

(ANOVA) and regression analyses, to identify trends and draw conclusions that have been verified by science. In addition to providing factual support for the argument for sustainable cabbage growing, this study aims to provide farmers and other agricultural stakeholders with pertinent information. The purpose of this study is to shed light on the intricate relationships between the growth and yield of cabbage and organic manures in an effort to enhance farming methods and promote a more sustainable and environmentally conscious approach to cabbage cultivation.

Location:

The Amity University Organic Farm in Noida, Uttar Pradesh, which has longitudes of 77.3330E and latitude of 28.5440° N, was the study's location. It occurred in 2023–2024 during the Rabi season at a height of 200 metres higher than the sea level.

Climate:

Noida located in Uttar Pradesh, India, experiences hot, dry summers and chilly winters due to its semi-arid and subtropical climate. This region is under the "Trans-Gangetic plains" agroclimatic region. The warmest months are May as well as June with average highs of 40 to 45 degrees Celsius. January is the coldest month of the year, with low temperatures ranging from 4°C to 7°C. From February to June, it slowly grows, yet as the south-west monsoon draws near, it begins to progressively decline. Over the course of the testing period, the average warmest temp was 35.21°C, while the average hottest temperature was 23.74°C. Monsoon rainfall totalled 141.26 mm. Every day, there was an average of 4.0 hours of sunlight. For the experiment, the average relative humidity was 60.5%.

3. Result and discussion:

The findings and evaluation of a research done in the 2023-2024 month of Rabi at Amity university Organic Agriculture Farm in Noida, Uttar Pradesh, are provided below. The study, titled " Efficacy of various organic and biofertilizer on the growth and yield of *Brassica oleracea L.* (Cabbage)," investigates the impact of various organic manures on cabbage production.

3.1 Growth Parameters

3.2 Yield Parameters

3.1 Growth Parameters:

We collected information on crucial development indicators such as plant size, the quantity of outer leaves, and the head diameter throughout the crop's life cycle. These measurements were obtained at various phases of development, including before the crop was harvested.

3.1.1 Plant height (cm)

Plant height is the single most important factor in crop development. The plant height was taken 30 DAS, 60 DAS, and 90 DAS in order to assess the effects of the various treatments that were provided to them, both alone and collectively.

There were notable variations in plant height, as shown by the data in Table 1 and figure 1. Treatment T4 (vermicompost + azotobacter) considerably raised the height of the plants at 30 DAS (16.2 cm) compared to the other treatments however treatment T6 (control) substantially lowered it (9.4cm).

There were notable variations in plant height, as indicated by the data in Table 1 and Figure 1. Similarly to the other treatment, Treatment T4 (vermicompost + azotobacter) had the highest plant height at 60 DAS (20.1 cm), whereas T6 (control) has the lowest (11.8 cm).

Significant differences in plant height were evident, as indicated by the data in table 1 and Figure 1. Treatment T4 (vermicompost + azotobacter) significantly raised the height of the plant at 90 DAS (24 cm) in comparison to other treatment whereas treatment T6 (control) significantly lowered it (16.4 cm). the plant received enough nutrients from the increased dose of mixed organic manures, which encouraged the production of metabolites and the activation of certain enzymes, increasing the gross and marketable output [18].

Table1: The effect of various treatments on plant height (cm)

TREATMENTS	30 DAS	60 DAS	90 DAS
T1-FYM	11.9	14.1	18.1
T2-VERMICOMPOST	13.1	15.1	21.0
T3-POULTRY MANURE	12.2	14	19
T4- VERMICOMPOST+ AZOTOBACTER	16.2	20.1	24
T5-POULTRY MANURE+ AZOTOBACTER	15.1	19.1	23.5
T6- CONTROL	9.4	11.8	16.4
C.D at 5%	0.5	0.4	0.5
SEm	0.16	0.13	0.16

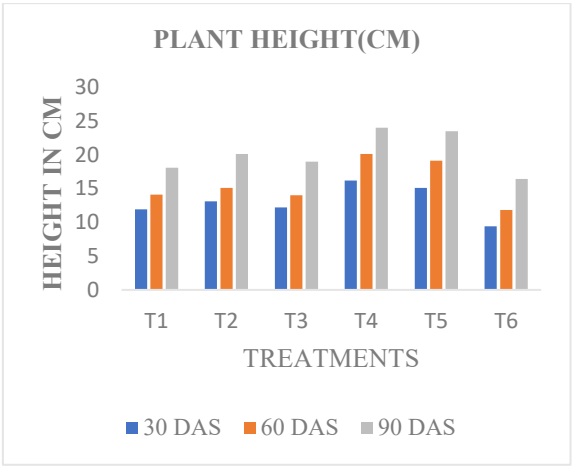

Fig.1: Effect of different treatments on plant height (cm)

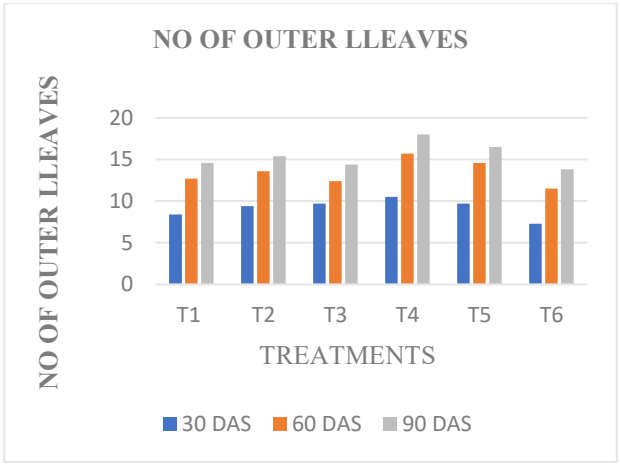

Figure 2: The effect of various treatments on the number of leaves on a plant

3.1.2 Number of outer leaves per plant

The number of outer leaves on each plant was counted at 30 DAS, 60 DAS, and 90 DAS intervals. Organic manures and bio-fertilizers, either alone or in combination, were found to have an effect on the quantity each plant's outer leaves.

At 30 DAS, every plant had a different number of outer leaves in each treatment. Out of all the treatments, T4 (vermicompost + azotobacter) had most leaves (10.5), whereas T6 (Control) had the fewest (7.3).

The total amount of leaves per plant varied significantly across all treatments at 60 DAS. T4 (vermicompost + azotobacter) was the treatment with the most leaves (15.5), whereas T6 had the lowest leaves (11.7).

The number of leaves on each plant at 90 DAS varied significantly between treatments. T4 (vermicompost + azotobacter) had the most leaves (18.0) of all the treatments, whereas T6 (Control) had the fewest (13.8).

Table.2: Effect of different treatments on number of outer leaves

TREATMENTS	30 DAS	60 DAS	90 DAS
T1 -FYM	8.4	12.7	14.6
T2-VERMICOMPOST	9.4	13.6	15.4
T3-POULTRY MANURE	9.7	12.4	14.4
T4-VERMICOMPOST+ AZOTOBACTER	10.5	15.7	18.0
T5-POULTRY MANURE+ AZOTOBACTER	9.7	14.6	16.5
T6- CONTROL	7.3	11.5	13.8
C.D at 5%	0.7	0.9	0.9
SEm	0.23	0.3	0.3

3.1.3 Head Diameters in cm

It was demonstrated that the number of branches per plant was affected by the application of biofertilizer to organic manures, as evidenced by the count of head diameters per plant at 60 and 90 DAS intervals in this study.

At 60 DAS, there were noticeable differences in each treatment's head diameter for each plant. The maximum head diameter per plant across all treatments was 11.4 cm for treatment T4 (vermicompost + azotobacter), whereas T6 (control) had the significantly shorter head diameter (7.1cm) than any other plant.

Across all treatments, there were noticeable differences in 90 DAS in the head diameter per plant. Treatment T4(vermicompost + azotobacter) had the largest head diameter per plant (22.4 cm) in comparison to all other treatments, whereas treatment T6 (control) had the smallest minimum head metre per plant (13cm).

Table 3: The effect of various treatments on each plant head diameter

TREATMENTS	60 DAS	90 DAS
T1-FYM	8.5	16.5
T2-VERMICOMPOST	9.3	18.2
T3-POULTRY MANURE	9.6	18.5
T4-VERMICOMPOST+ AZOTOBACTER	11.4	22.4
T5-POULTRY MANURE+ AZOTOBACTER	10.9	21.2
T6- CONTROL	7.1	13.0
C.D at 5%	0.4	1.0
SEm	0.13	0.33

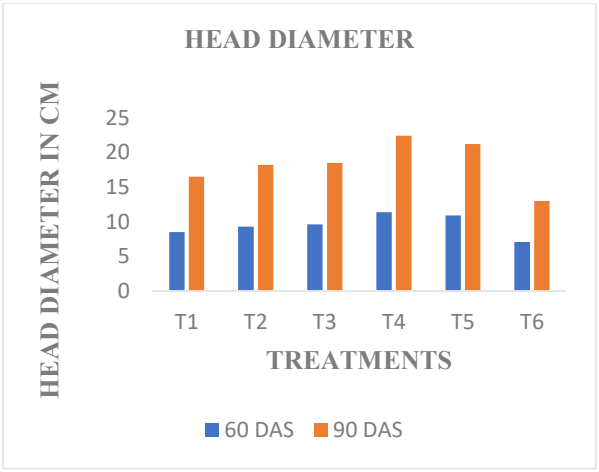

Figure 3: The effect of various treatments on the diameter of each plant's head.

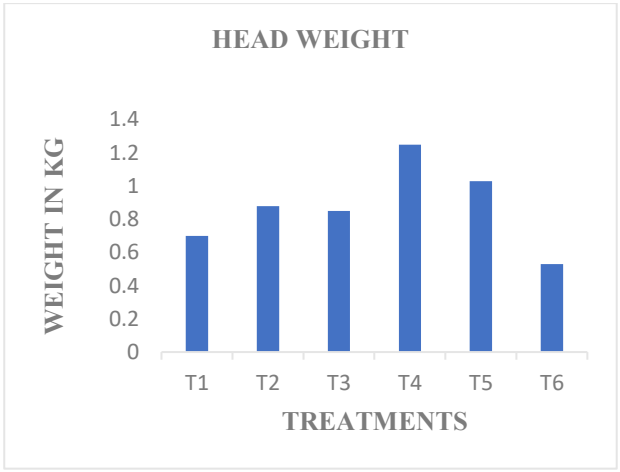

Figure 4: The effect of various treatments on head weight

3.2 Yield Parameters

At the time of crop harvest, records were kept on the yield metrics head weight and total yield.

3.2.1 Head weight

It was demonstrated that the use of biofertilizers and organic manures, either separately or in combination, had an impact on head weight.

At the harvest stage, there was a substantial different in head weight across all treatment. Treatment T4 (vermicompost + azotobacter) had the highest head weight (1.26 kg) at the time of the first harvest, whereas T6 (control) had the lowest head weight (0.53 kg), which was significantly lower.

Table 4: The effect of various treatments on the head weight

TREATMENTS	HEAD WEIGHT IN KG
T1-FYM	0.70
T2-VERMICOMPOST	0.88
T3-POULTRY MANURE	0.85
T4-VERMICOMPOST+ AZOTOBACTER	1.26
T5- POULTRY MANURES + AZOTOBACTER	1.03
T6- CONTROL	0.53
C.D at 5%	0.1
SEm	0.03

3.2.2 Yield per plot

Table.5 presents the effect of various treatments on the yield per plot, measured in kilograms. Among the treatments, vermicompost + azotobacter (T4) exhibited the highest yield per plot at 15.88 kg, followed by poultry manure + azotobacter (T5) at 13.03 kg. Vermicompost alone (T2) also showed a notable yield of 13.5 kg per plot. Conversely, the control (T6) yielded the lowest at 10.13 kg per plot. These results highlight the significant impact of organic manures and biofertilizers, particularly vermicompost combined with azotobacter, in enhancing cabbage yield per plot compared to conventional methods.

Table 5: The effect of various treatments on the yield per plot

TREATMENTS	YIELD PER PLOT (KG)
T1-FYM	11.7
T2-VERMICOMPOST	13.5
T3- POULTRY MANURE	12.27
T4- VERMICOMPOST + AZOTOBACTER	15.88
T5-POULTRYMANURE + AZOTOBACTER	13.03
T6-CONTROL	10.13
C.D at 5%	0.51
SEm	0.17

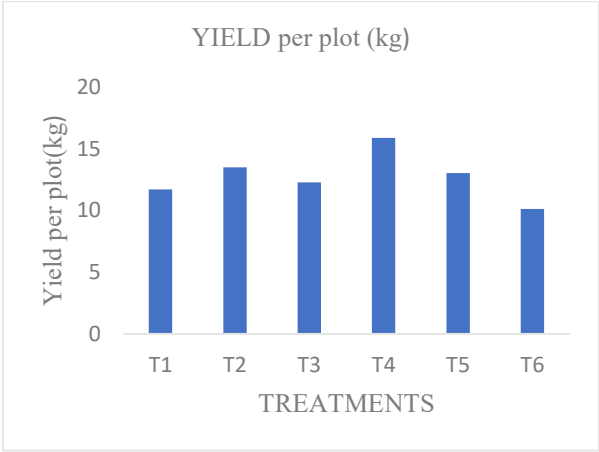

Figure 5: The effect of various treatment on the yield per plot

3.2.3 Total yield (t/ha)

The entire plant yield was measured at the time of crop harvest. It was demonstrated that the use of biofertilizers and organic manures, both alone and in combination, had an impact on the total yield.

When it came to the crop's overall output, there was a discernible difference between all treatments at the crop harvest stage. When it came time for harvest, T4 (vermicompost + azotobacter) produced the most yield per hectare (29.98 t/ha), whereas T6 (control) produced the least (specifically,20.87t/ha).

Table 6: The effect of various treatments on the yield (t/ha)

TREATMENTS	**YEILD (t/ha)**
T1-FYM	16.72
T2-VERMICOMPOST	19.29
T3- POULTRY MANURES	17.52
T4- VERMICOMPOST + AZOTOBACTER	22.69
T5-POULTRYMANURE+ AZOTOBACTER	18.62
T6- CONTROL	14.48
C.D at 5%	0.73
SEm	0.24

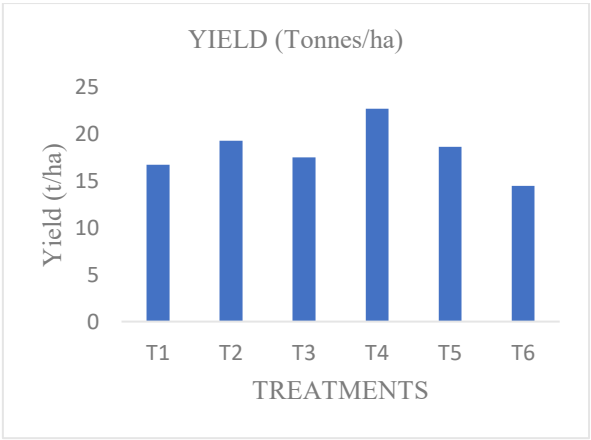

Figure 6: The effect of various treatments on the total yield(t/ha)

Conclusion

The results of this study, along with the agroclimatic characteristics of was carried out at Amity Institute of Organic Agriculture's research farm in Amity University Noida, Uttar Pradesh, indicate that growing this cultivar of *Brassica oleracea* cabbage with vermicompost + azotobacter will yields higher crop yields per hectare than growing it with other organic manures and biofertilizer.

References:

1. S. A. Ansari, S. R. Patil, P. R. Jadhav. Influence of different organic manures on cabbage's growth, yield, and quality (*Brassica oleracea* var. Capitata L.). Journal of Applied and Natural Science (2020).
2. Food and Agriculture Organization (FAO). FAOSTAT - Food and Agriculture Data. [http://www.fao.org/faostat/en/](2022).
3. Agricultural and processed food productions export development authority (APEDA). National Horticulture Board (NHB) https://apeda.gov.in/apedawebsite/index.html (2022).
4. K. A. Steinmetz, J. D. Potter. Vegetables, fruit, and cancer prevention: a review. Journal of the American Dietetic Association, **96**, 1027-1039 (1996).
5. S. C. Ogbede, A. N. Saidu, A. Y. Kabiru, M. B. Busari. Nutrient and Anti-Nutrient Compositions of *Brassica Oleracae Var. Capitata L*. IOSR Journal of Pharmacy PP 19-20.
6. M. Baranski, D. Srednicka-Tober, N. Volakakis, C. Seal, R. Sanderson, G. B. Stewart, C. Leifert. Higher antioxidant and lower cadmium concentrations and lower incidence of pesticide residues in organically grown crops: a systematic literature review and meta-analyses. British Journal of Nutrition, **112**, 794-811 (2014).
7. F. Zhang, X. Chen. Nutrient use efficiency of crops: Concepts and approaches. Springer Science & Business Media (2012).
8. D. Tilman, K. G. Cassman, P. A. Matson, R. Naylor, S. Polasky. Agricultural sustainability and intensive production practices. Nature, **418**, 671-677 (2002).
9. S. R. Carpenter, N. F. Caraco, D. L. Correll, R. W. Howarth, A. N. Sharpley, V. H. Smith. Nonpoint pollution of surface waters with phosphorus and nitrogen. Ecological Applications, **8**, 559-568 (1998).
10. V. Pandey, M. Patel, H. Kaur. Comparison of the effect of different organic manures on the growth and yield of cabbage (*Brassica oleracea var. Capitata*). Journal of Agricultural and Biological Science. 546-549 (2017).
11. J. P. Reganold, J. D. Glover, P. K. Andrews, H. R. Hinman. Sustainability of three apple production systems. Nature, **410**, 926-930 (2001).
12. P. Garg, A. Gupta, S. Satya. Vermicomposting of different types of waste using *Eisenia foetida* A comparative study. Bioresource Technology, **97**, 391-395 (2006).
13. M. A. Altieri, C. I. Nicholls. Soil fertility

management and insect pests: harmonizing soil and plant health in agroecosystems. Soil and Tillage Research, **72**, 203-211 (2003).
14. R. Lal. Soil carbon sequestration impacts on global climate change and food security. Science **304**, 1623-1627 (2004).
15. IFOAM - Organics International. (n.d.). Why Organic? Retrieved from https://www.ifoam.bio/why-organic.
16. C. M. Benbrook. Elevating antioxidant levels in food through organic farming and food processing. In The organic center critical issue report. The Organic Center (2005).
17. A. C. Weibull, J. Bengtsson, E. Nohlgren. Diversity of butterflies in the agricultural landscape: the role of farming system and landscape heterogeneity. Ecography, **23**, 743-750 (2000).
18. M. L. Bhardwaj, R. Harender, B. L. Koul. Yield response and economics of organic sources of nutrients as substitutes to inorganic sources in tamato (*Lycopersicon eseulentum*), okra (*Hibiscus esculentus*), cabbage (*Brassica oleracea var. capitata*) and cauliflower (*B. oleracea var. botrytis*). Indian Journal of Agricultural Science **70**, 653-656 (2000).