Impact of varied organic manures and biofertilizers on the growth and yield of fenugreek cultivation

Shubhi Agrawal[1], *Khuraijam* Panthoi Chanu[1] , *Vaibhav* Bopche[1] , and *Abha* Sharma[1,*]

[1]Amity Institute of Organic Agriculture, Amity University 201313 Uttar Pradesh, Noida, India

Abstract Organic manures and biofertilizers have a good effect on soil structure and microbial populations, according to studies such as those which can improve the overall health of the agriculture system. The study focuses on the growth, yield-attributing traits, and economic considerations of fenugreek, which is a member of the Fabaceae family and is well-known for its culinary and therapeutic benefits. A recent study was conducted at the Amity Institute of Organic Agriculture's research farm at Amity University Noida (Uttar Pradesh) during Rabi season 2023-24 to explore the impact of using different organic manures and biofertilizers on fenugreek production. The experiment was laid out in a randomized block design with three replications comprising six treatments. The study used field trials to compare the results of these approaches to traditional methods and analyse their economic feasibility. The results showed that using organic inputs, particularly vermicompost mixed with Azotobacter, significantly improved plant growth and yield. The best results for growth parameters *viz.* plant height (34.33 cm), and the number of branches per plant (11.77) were recorded in plots applied with (T4) (Vermicompost +Azotobacter), Additionally, treatments that used bio fertilisers alongside organic manures produced higher net returns and benefit-cost ratios than treatments that only used organic manures. Numeric assessments demonstrated the economic viability of using organic manure combinations, with T4 (vermicompost + Azotobacter) yielding the highest net return of 119,389 rupees. These findings highlight the potential of organic inputs in sustainable fenugreek growing, providing farmers and stakeholders with useful insights into promoting environmentally friendly agricultural practices.

Keywords: Organic manures, FYM, vermicompost, poultry manure, plant growth parameters, yield.

1 Introduction

Fenugreek *(Trigonella foenum-graecum)* is a perennial plant that belongs to the Fabaceae family. It is known for its leguminous character and its trifoliate leaves, little white flowers, and distinctive seeds. Fenugreek is part of the *Trigonella* genus, which includes various species recognised for their aromatic properties and wide range of applications, from culinary to medical. The plant is also well-known for having a high concentration of bioactive components, including alkaloids, flavonoids, and saponins. A taxonomic perspective is essential for a comprehensive examination of the costs and benefits associated with various organic inputs [1]. The benefits of fenugreek and its potential applications [2].

Fenugreek is a plant that is native to the Mediterranean region, including Western Asia and Southern Europe [3]. The Middle Ages saw its distribution expand to China and India [4]. Fenugreek seeds are a great source of protein and are an essential part of many diets. They are also loaded with dietary fibre, which helps in digestion. Moreover, fenugreek seeds are rich in minerals like iron, calcium, and magnesium, and contain various B-complex vitamins that promote overall nutritional balance. In addition, fenugreek seeds have antioxidant properties that promote good health and fight oxidative stress [5]. The antioxidant activity of fenugreek seeds provides insights into how they can improve overall health.

Recent data analysis shows that only a few countries are the primary exporters of fenugreek. India is the world's largest grower of fenugreek, with Rajasthan being responsible for more than 80% of the country's fenugreek production. Other regions where fenugreek is grown include Gujarat, Madhya Pradesh, Chhattisgarh, and Uttar Pradesh. India is a significant exporter due to its massive fenugreek crop, accounting for 11.22% and 69.29% of the total area and production of seed spices in 2019-20. Fenugreek currently yields 1566 kg/ha and has a seed production of 1,88,480 tons on 1,20,340 hectares of land under cultivation [6].

Fenugreek seeds and leaves have a unique and noticeable impact on a variety of dishes. The seeds' slightly bitter taste is a common ingredient in curry mixes, while the leaves add their distinctive flavour to dishes like fenugreek-based bread and stews.

Fenugreek has been utilized in traditional medicine for ages because of its health benefits. The herb is well-known for its anti-inflammatory effects and is commonly used to treat ailments like inflammation and digestive disorders [7]. Fenugreek is well-known for its galactagogue properties, making it a popular choice among nursing women looking to stimulate their breast

*Correspondence Author: abhasharma22nov@gmail.com

milk supply. Studies have shown that fenugreek has anti-inflammatory and antioxidant benefits due to its flavonoids and saponin components. These properties are being explored for their potential utility in the treatment of oxidative stress and inflammatory chronic diseases [8].

Fenugreek is a versatile herb that is now being used in the corporate world, especially in the fragrance industry where it contributes to the manufacturing of perfumes, soaps, and lotions due to its fragrant properties. Additionally, research suggests that fenugreek has potential benefits in managing diabetes, as it may help to decrease blood sugar levels. Chemical fertilizers are designed to deliver precise nutrient formulations quickly. The fast-acting nutrients in these fertilizers can result in rapid initial growth responses.

There are concerns about the potential negative effects on soil health and sustainability due to the use of chemical fertilizers. A study on nutrient use efficiency highlights the importance of precise nutrient control in chemical fertilization [9]. While chemical fertilizers are necessary to provide crops with the nutrients they need, overuse, irregular application, and frequent application can damage the soil's physical and chemical properties, reduce the quality of the goods produced, and ultimately lead to lower crop yields. However, the introduction of commercial cultivars and intensive cultivation techniques has increased the need for micronutrients to ensure the long-term viability of agricultural output. To maintain soil fertility, it is important to use all available approaches, including chemical, organic, and biological fertilizers. When aiming to keep costs in mind, it is critical to use all available nutrient sources and supplement chemical fertilizers with the crop's nutritional requirements [10].

Organic manures can affect the nutritional quality of fenugreek seed [11].

An overview of biofertilizers and their role in promoting sustainable agriculture [12]. This overview sets the framework for future research into the potential impact of biofertilizers on fenugreek seed. Organic fertilizers that are derived from natural sources like compost, manure, and plant scraps offer a comprehensive approach to soil enrichment. Organic matter treatment encourages nutrient release and microbial activity over time, which can have a positive impact on soil structure and microbial populations. Organic manures and biofertilizers can improve the overall health of the agricultural system [13]. Biofertilizers are living microorganisms that create symbiotic relationships with plants, enhancing nutrient mobilization and uptake [14]. The nutrient composition of both organic and artificial fertilizers has a significant impact on plant growth. Organic manures are rich in a variety of nutrients, which help to establish a more balanced soil nutrition and promote better plant growth. On the other hand, chemical fertilizers may have a low organic matter content, which is essential for improving soil structure. The crucial role of nutrient interactions and availability in shaping plant responses to different types of fertilizers [15].

The debate on organic vs. chemical fertilizers revolves around their effect on soil health and microbial activity. Legume-based cropping systems, commonly associated with organic farming, result in lower carbon and nitrogen losses, indicating better soil health [16]. Research on fenugreek growth shows that both organic and chemical fertilizers can have a significant impact on plant development. The long-term benefits of organic manures are crucial for sustainable agriculture [17].

The diverse facets of nutrient efficiency and their impact on crop yield [18]. The economic benefits of enhancing soil microbial properties through organic methods [19].

The study focused on the growth and yield of fenugreek using varied organic manures and biofertilizers.

2 Materials and methods

The pursuit of sustainable and ecologically sensitive agricultural technologies is crucial in today's ever-changing world of agriculture. This study was conducted during the Rabi season in 2023-2024. The content and methodology of this study were thoroughly reviewed to provide a comprehensive and systematic approach. Standardized fenugreek seeds were cultivated in controlled environments in experimental plots. To eliminate bias, the experimental design comprises randomized blocks, and various organic inputs such as compost, vermicompost, and farmyard manure will be strategically applied at different growth stages. These organic inputs will be supplemented by biofertilizers containing helpful microorganisms. The data collection process will be thorough, covering a wide range of plant development and productivity.

The study will be strengthened by conducting statistical analyses such as ANOVA and regression analysis. These analyses will reveal trends and help draw scientifically sound conclusions. The purpose of this study is not only to contribute to the scientific discussion on sustainable agriculture but also to provide practical insights for farmers, policymakers, and agricultural practitioners who aim to balance production and environmental stewardship in fenugreek farming. We hope that our analysis will lead to better decision-making and a more sustainable future for fenugreek cultivation.

2.1 Location

The experiment occurred at Amity University Organic Farm in Noida, Uttar Pradesh. It was located 200 meters above mean sea level at 28.5440° N and 77.3330E longitudes.

2.2 Climate

Noida, located in Uttar Pradesh, experiences semi-arid and subtropical climates. The region has hot and dry summers, with the warmest months being May and June, where the maximum temperature ranges from 40°C to 45°C. The winters are cold, with January being the coldest month, and average minimum temperatures ranging from 4°C to 7°C. The climate falls under the "Trans-Gangetic plains" agro-climatic zone. The temperature gradually

increases from February to June before decreasing as the southwest monsoons approach. During the trial period, the average highest temperature was 35.21°C, while the average lowest temperature was 23.74°C. The monsoon season brought 141.26 milli - metres of rain. The average amount of sunlight each day has decreased to around 4.0 hours, and the average relative humidity (RH) during the test period was 60.5%. The climate data were collected from the Indian Meteorological branch in Faridabad (UP) during the experiment.

3 Result and discussion

A study on the "Impact of Varied Organic Manures and Biofertilizers on the Growth and Yield of Fenugreek Cultivation" was conducted at Amity University's Organic Agriculture Farm in Noida, Uttar Pradesh during the rabi season of 2023-2024. The study's results are presented and discussed below.

3.1 Growth Parameters

Plant growth characteristics were assessed at various stages of crop development and before harvest. The parameters were plant height, number of leaves, branches, and leaf area. Detailed records of these measures were meticulously maintained for review.

3.1.1 Plant Height (cm)

Crop growth is highly dependent on plant height. To explore the impact of various treatments on the plants individually and in combination, plant heights were measured on three separate plates: 20 DAS, 40 DAS, and 60 DAS.

The results reported in the table show that plant heights vary significantly across treatments. Treatment T4, which included vermicompost and azotobacter, resulted in a considerable increase in plant height, with plate number one measuring 15.37 cm. Treatment T6, which acted as the control, significantly dropped plant height, measuring 10.53 cm.

The table below shows data demonstrating a considerable difference in plant height. Treatment T4 (vermicompost + azotobacter) resulted in a substantial increase in plant height at 40 DAS (28.46 cm) compared to the other treatments, but Treatment T6 (control) resulted in a significant decrease (21.03 cm).

The data in the table revealed significant variations in plant height. Treatment T4 (vermicompost + azotobacter) expanded significantly at 60 DAS, reaching a height of 34.33 cm, however, Treatment T6 (control) reduced plant height to 23.17 cm compared to the other treatments.

Plant height differences were induced by both genetic and environmental factors [20].

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

TREATMENTS	20 DAS	40 DAS	60 DAS
T1-FYM	11.3	22.37	25.77
T2-VERMICOMPOST	13.03	24.51	27.77
T3-POULTRY MANURE	12.20	23.47	27.23
T4-VERMICOMPOST+ AZOTOBACTER	15.37	28.46	34.33
T5-POULTRY MANURE+ AZOTOBACTER	14.07	26.43	30.33
T6- CONTROL	10.53	21.03	23.17
C.D at 5%	0.6	0.8	1.4
SEm	0.2	0.26	0.46

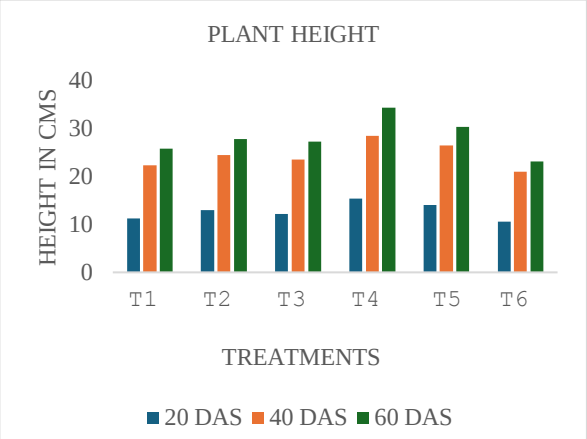

Fig.1: Effect of different treatments on plant height (cm)

3.1.2 Number of leaves per plant

The number of leaves per plant was counted at three different intervals: 20 DAS, 40 DAS, and 60 DAS. The study discovered that applying organic manures and bio-fertilizers, alone or in combination, influenced the number of leaves per plant.

During the first period, the number of leaves per plant varied significantly across all treatments. T4 (vermicompost + azotobacter) had the most leaves (20), while T6 (Control) had the fewest (12) by a large margin.

In the 40-day trial, there was a substantial difference in the number of leaves per plant between all treatments. T4 (vermicompost + azotobacter) had the most leaves (45), followed by T6 (Control) with the fewest (26).

Similarly, at 60 DAS, the number of leaves per plant varied significantly across treatments. T4 (vermicompost + azotobacter) had the most leaves (65), while T6 (Control) had the fewest (33).

Genetic and environmental factors influence varietal features such as leaf number [21].

Table 2: Effect of different treatments on the number of leaves per plant

TREATMENTS	20 DAS	40 DAS	60 DAS
T1-FYM	12.70	31.67	43.90
T2-	13.30	34.27	54.90

VERMICOMPOST			
T3-POULTRY MANURE	13.17	33.73	51.93
T4-VERMICOMPOST+ AZOTOBACTER	20	45	65
T5-POULTRY MANURE+ AZOTOBACTER	18.10	42.37	59.13
T6- CONTROL	12.00	26	33
C.D at 5%	1.06	1.4	3.25
SEm	0.35	0.46	1.08

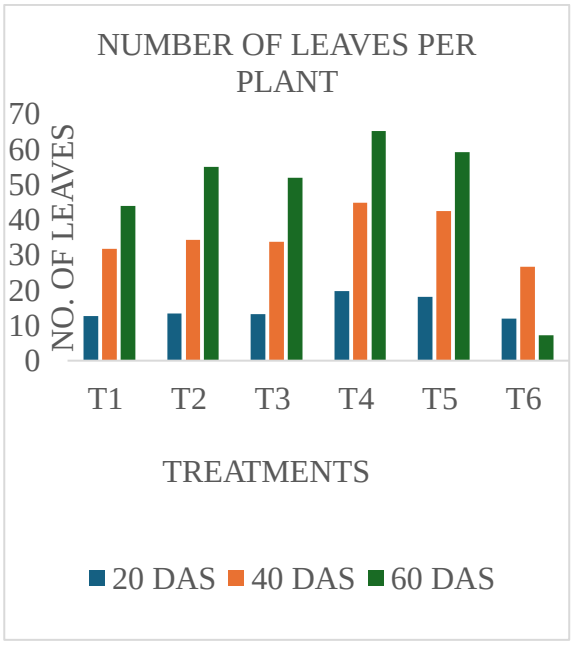

Fig.2: Effect of different treatments on the number of leaves per plant

3.1.3 Number of branches per plant

Throughout the experiment, the number of branches per plant was recorded at regular intervals on plates 1, 2, and 3. The study found that applying organic manures and biofertilizers enhanced the number of branches per plant.

Further study found a substantial difference in the number of branches per plant across all treatments on plate number one. Treatment T4, which contained vermicompost and azotobacter, had the most branches per plant (6.27), while T6, the control group, had the fewest.

The number of branches per plant at 40 DAS differed considerably across treatments. Treatment T4, which included vermicompost and azotobacter, produced the most branches per plant (8.23) when compared to the other treatments. In contrast, the control treatment T6 had the fewest branches per plant (5.23).

Furthermore, after 60 DAS, all treatments demonstrated a significant increase in the number of branches per plant. Treatment T4 had the most branches per plant (11.77) of any treatment, while control treatment T6 had the fewest (8.57).

Varieties grown in appropriate agronomic and climatic conditions exhibit variability in overall growth, which could be related to genetics and photosynthesis. This improves the absorption and utilization of radiant energy, resulting in maximum dry matter accumulation and the number of primary and secondary branches.

Genetic and environmental factors can both contribute to variation [22].

Table 3: Effect of different treatments on number of branches per plant

TREATMENTS	20 DAS	40 DAS	60 DAS
T1-FYM	4.40	6.30	9.80
T2-VERMICOMPOST	5.51	7.40	10.13
T3-POULTRY MANURE	5.53	7.00	9.07
T4-VERMICOMPOST+ AZOTOBACTER	6.27	8.23	11
T5-POULTRY MANURE+ AZOTOBACTER	5.07	7.30	10.9
T6- CONTROL	4.07	5.23	8.57
C.D at 5%	0.5	0.6	1.05
SEm	0.16	0.2	0.35

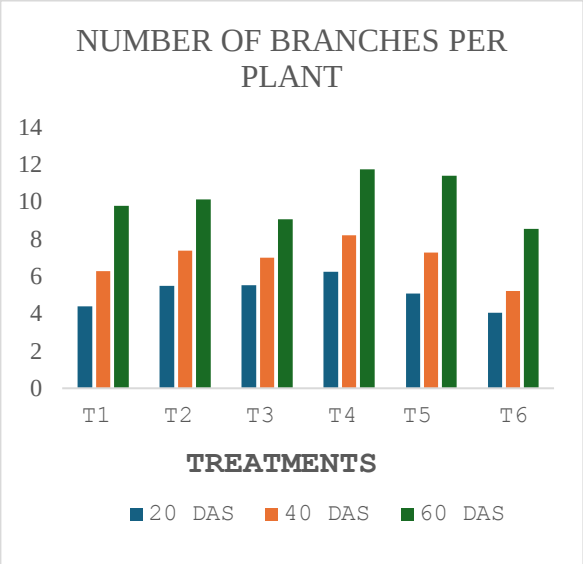

Fig.3: Effect of different treatments on the number of branches per plant

3.1.4 Leaf area (cm²)

To explore the effect of organic manures and biofertilizers on plant growth, leaf area was measured at 20, 40, and 60 DAS.

At 20 DAS, all treatments showed significant increases in plant leaf area. T4, which contains vermicompost and azotobacter, had the biggest leaf area of all treatments, measuring 42.16 cm^2. On the other hand, T6, the control group, had the smallest leaf area at 25.60 cm^2.

Similarly, at 40 DAS, all treatments demonstrated significant increases in plant leaf area. T4 had the largest leaf area (66.39 cm^2), whereas T6 had the smallest (48.19 cm^2).

At 60 DAS, plant leaf area differed considerably between treatments. T4 had the largest plant leaf area of 81.06 cm2 of any treatment, while T6 had the smallest leaf area of 69 cm^2.

An increase in leaf area in T4 (vermicompost + azotobacter) might be due to the maximum size and number of leaves during the growth phase which enhanced the photosynthetic surface area hence increased leaf area was observed [23].

Table 4: Effect of different treatments on the plant leaf area (cm^2)

TREATMENTS	20 DAS	40 DAS	60 DAS
T1-FYM	32.08	51.77	74.06
T2-VERMICOMPOST	34.58	54.79	75.88
T3-POULTRY MANURE	33.76	54.00	73.86
T4-VERMICOMPOST+ AZOTOBACTER	42.16	66.39	85.15
T5-POULTRY MANURE+ AZOTOBACTER	38.63	63.85	81.06
T6- CONTROL	25.60	48.19	69.00
C.D at 5%	1.51	1.21	1.85
SEm	0.50	0.40	0.61

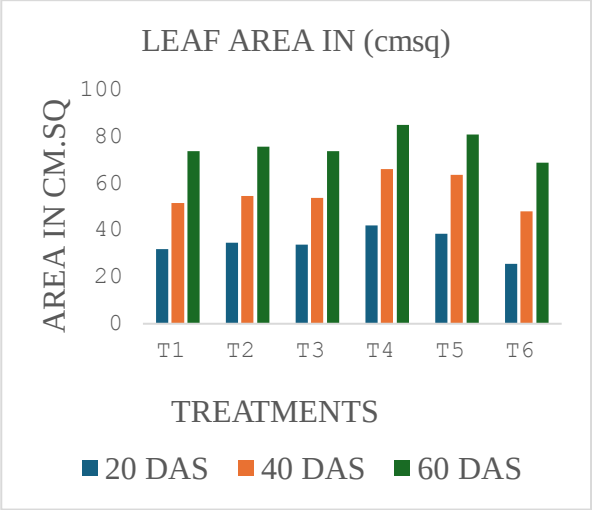

Fig.4: Effect of different treatments on plant leaf area (cm^2)

4. Yield parameters

Data on yield characteristics, such as plant weight and total yield, were recorded during the crop's first and second harvest.

4.1 Yield per plot (kg/ha)

The entire plant yield of the crop was measured during the first and second harvests, and it was discovered that organic manures and bio-fertilizers, both independently and in combination, affected output.

Crop output changed significantly between treatments at the first harvest stage. At the first harvest stage, T4 (vermicompost + azotobacter) had the maximum crop output (2047.62kg/ha), while T6 (Control) had the lowest plant yield.

The crop output at the second harvest stage differed significantly across all treatments. At the first harvest, T4 (vermicompost + azotobacter) had the highest crop output (5238.10 kg/ha), whereas T6 (Control) had the lowest plant yield (1761.90 kg/ha), although it was still significantly higher than the other treatments.

These genotypes may produce more herbage due to increased branching and leaf count [24].

Table 5: Effect of different treatments on the yield per plot(kg/ha)

TREATMENTS	FIRST HARVEST	SECOND HARVEST
T1-FYM	1619.05	1100.00
T2-VERMICOMPOST	1290.48	1695.24
T3-POULTRY MANURE	1476.19	2790.48
T4-VERMICOMPOST+ AZOTOBACTER	2047.62	3095.24
T5-POULTRY MANURE+ AZOTOBACTER	1161.90	2095.24
T6- CONTROL	919.05	1047.62
C.D at 5%	524.22	555.79
SEm	174.74	185.26

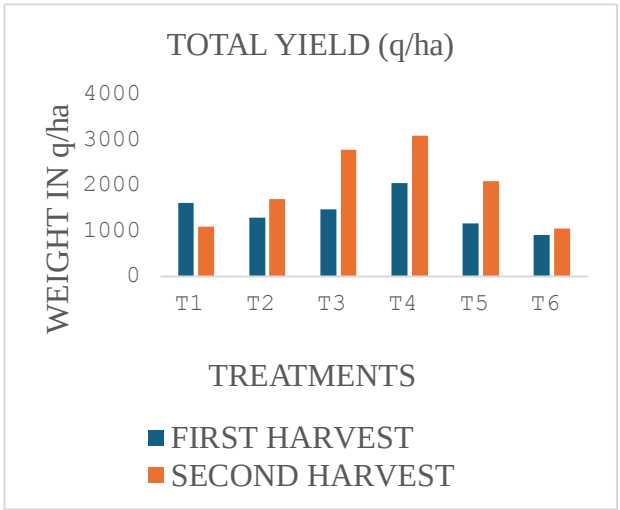

Fig. 5: Effect of different treatments on total yield (kg/ha)

5 Conclusion

A recent study was conducted at the Amity Institute of Organic Agriculture's research farm at Amity University Noida, Uttar Pradesh. The study revealed that growing Fenugreek *Trigonella foenum graecum* with Vermicompost and Azotobacter (T4) resulted in significantly higher plant growth and crop yield per hectare. This method proved to be more effective than other organic manures and bio-fertilisers.

References

1. A. Smith. Phosphorus Dynamics and Fenugreek Growth. Journal of Soil Science, **25**, 123-140 (2018)
2. R. L. Bugg. Organic Farming, Soil Health, and Food Quality: Considering Possible Links. Advances in Agronomy **98,** 1-36 (2008)
3. United States Department of Agriculture. (USDA,2021). (https://www.usda.gov/)
4. A. Ahmad, S. S. Alghamdi, K.Mahmood, and M.Afzal . Fenugreek a multipurpose crop: Potentialities and improvements National Institutes of Health 21-23 (2015)
5. Al-Jasass, F. M. Nutritional Composition of Fenugreek Seeds and Its Potential as a Functional Food. Food & Nutrition Research **56**, (2012)
6. Food and Agriculture Organization (FAO) (2022). FAOSTAT - Food and Agriculture Data. [http://www.fao.org/faostat/en/] (http://www.fao.org/faostat/en/)
7. Directorate of Arecanut and Spices Development Ministry of Agriculture and Farmers Welfare DASD, Kozhikode). https://spicenurseries.in/ November 1, (2009)
8. R. D. Sharma. Effect of fenugreek seeds and leaves on blood glucose and serum insulin responses in human subjects. Nutrition Research **6**, 1353-1364 (1986)
9. N. A. Hassan, M. B Salem, A. A. Sayed, & R. El-Seady. Influence of fenugreek seeds content on quality attributes and antioxidant activity of flatbread. Journal of Food Science and Technology **54**, 667-676 (2017)
10. N Neelakantan, M. Narayanan, de Souza, R. J., van Dam, R. M., & W. P. Koh. The effect of fenugreek supplementation on plasma testosterone and markers of oxidative stress in male subjects. Phytotherapy Research **28**, 182-185 (2014)
11. F. Zhang, & X. Chen. Nutrient use efficiency of crops: Concepts and approaches. Springer Science & Business Media **54**, 667-676 (2012)
12. C. Thapa , S. Pandey , V. Kumar and M. Kumar. Effect of Integrated Nutrient Management on Growth and Yield Characteristics of Cauliflower (Brassica oleracea var. botrytis L.) cv. Snow Crown Biological Forum – An International Journal **14**, 31-39 (2022)
13. A. Gajbhiye. Effect of Organic Manures on Nutritional Quality and Antioxidant Activities of Aloe vera (L.) Burm. f. Journal of Pharmacognosy and Phytochemistry **8**, 4714-4718 (2019)
14. R. P. Singh. Biofertilizers in Sustainable Agriculture: An Overview on Concepts, Approaches, and Technologies. 3 Biotech **6**, 1-13 (2016)
15. A. Adholeya, and A. Kaur. Decomposition of different organic materials in a semi-arid tropical soil under long-term field conditions. Bioresource Technology **96**, 653-660 (2005)
16. R. C. Rajput. Biofertilizers in Agriculture: An Overview. Journal of Agroecology and Natural Resource Management **1,** 69-75 (2012)
17. H. Marschner. Mineral nutrition of higher plants. Academic Press 28(2), 182-185 (2011)
18. L. E. Drinkwater, P. Wagoner, & M. Sarrantonio. Legume-based cropping systems have reduced carbon and nitrogen losses. Nature **396**, 262-265 (1998)
19. K. G. Cassman, & P. L. Pingali. Intensification of irrigated rice systems: Learning from the past to meet future challenges. Nutrition Research, Bioresource Technology **6**, 1354-1364 (1995)
20. S. Goyal, K. Chander, M. Mundra, &, K. K. Kapoor. Influence of inorganic fertilizers and organic amendments on soil organic matter and soil microbial properties under tropical conditions. Biology and Fertility of Soils **29**, 196-200 (1999)
21. P. Bhojanagouda. Evaluation of fenugreek genotypes under the northern transitional belt of Karnataka. M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad, Karnataka India (2011)
22. TP. Malik, SK. Tehlan. Performance of fenugreek (*Trigonella foenum-graecum*) genotypes for growth and seed yield. Ann. of Hort. **2**, 237-239 (2009)
23. BR. Kuri, NL. Jat, AC. Saharawat YS,RS.Bana ,RS. Dadarwal. Effect of time, varieties and plant growth regulators on growth, physiological indices, and productivity of coriander (*Coriandrum sativum*). Indian J. Agro **60**, 464-470 (2015)
24. S. Datta, R. Chatterjee. Performance of Fenugreek (*Trigonella foenum-graecum* L.) genotypes under the new alluvial zone of West Bengal. J. Spices and Aromatic Crops **13**,132-134 (2004)