Agriculture Association of Textile Chemical and Critical Reviews Journal (2025) 138-143

AATCC Review

24 October 2024: Received
28 December 2024: Revised
22 January 2025: Accepted
28 January 2025: Available Online

https://aatcc.peerjournals.net/

Original Research Article | Open Access

Influence of drip nutrigation on the curd quality and nutrient uptake of cauliflower crop cultivation using bioslurry

Sidhartha Gaddam[1], Susama Sudhishri*, Manoj Khanna[1], Khajanchi Lal[1], Livleen Shukla[2], Rajiv Kumar[3], Arti Bhatia[4], Anupama Singh[5], K K Bandyopadhyay[6], Anchal Dass[3], Rashmi Yadav[7], Suneha Goswami[8], Sangeeta Kumari[1]

[1]*Water Technology Centre, ICAR-Indian Agricultural Research Institute, New Delhi, India*
[2]*Division of Microbiology, ICAR-Indian Agricultural Research Institute, New Delhi, India*
[3]*Division of Agronomy, ICAR-Indian Agricultural Research Institute, New Delhi, India*
[4]*Division of Environmental Science, ICAR-Indian Agricultural Research Institute, New Delhi, India*
[5]*Dean, ICAR-Indian Agricultural Research Institute, New Delhi, India*
[6]*ICAR-Indian Institute of Water Management, Bhubaneswar, Odisha*
[7]*Mahatma Gandhi University of Horticulture and Forestry, Durg, Chhattisgarh*
[8]*Division of Biochemistry, ICAR-Indian Agricultural Research Institute, New Delhi, India*

ABSTRACT

A field experiment was conducted during rabi-2023-24, on a cauliflower crop under drip irrigation using bioslurry as a nutrient source. Bioslurry was incubated with bio-decomposer and then treated bioslurry filtered through a developed cascade filter system. After filtration, the challenge was reduction in nutrients. Therefore, biofertilizers (Azotobacter, phosphorous solubilizing bacteria, and potassium mobilizing bacteria) along with filtered bioslurry through drip system, soil application and seed treatment were used to compensate the nutrient loss and for crop growth improvement and productivity. The experimental treatments included two Irrigation levels viz, drip irrigation at 80% ETc (I_1) and drip irrigation at 100% ETc (I_2) and six nutrigation levels including filtered slurry nutrigation alone (N_1), filtered bioslurry + biofertilizer nutrigation (N_2), filtered bioslurry + biofertilizer soil application (N_3), filtered bioslurry + biofertilizer seed treatment (N_4), drip fertigation at 100% RDF (N_5), control: only drip Irrigation + no fertigation (N_6). Drip fertigation at 100% RDF (N_5) recorded the highest nitrogen uptake (246.9 kg ha^{-1}),phosphorous uptake (58.6 kg ha^{-1}), potassium uptake (218 kg ha^{-1}) followed by filtered bioslurry + biofertilizer soil application (N_3) (211.2, 52.9, 199.9 kg ha^{-1}), filtered bioslurry + biofertilizer nutrigation (N_2) (212.3, 52.7, 198.4 kg ha^{-1}) and lowest uptake recorded at control: only drip irrigation + no fertigation (N_6) (92.5, 15.8, 74.8 kg ha^{-1}). Drip Irrigation at 100% ETc, recorded the highest curd yield (16.3 t ha^{-1}), which was comparable with drip Irrigation at 80% ETc (15.1 t ha^{-1}) Drip fertigation at 100% RDF(N_5) recorded significantly higher curd yield (21.25 t ha^{-1}). Filtered bioslurry + biofertilizer soil application and filtered bioslurry + biofertilizer nutrigation treatment recorded curd yield (17.12, 17.05 t ha^{-1}) respectively, which were comparable with each other. filtered bioslurry + biofertilizer seed treatment and filtered slurry nutrigation alonetreatments recorded curd yield (15.47, 13.80 t ha^{-1}) respectively. Obviously, the lowest curd yield (9.43 t ha^{-1}) was obtained in control treatment. The quality parameters like total sugars and ascorbic acid content were highest with filtered bioslurry + biofertilizer soil application (6.02%, 111.49 mg100g^{-1}) and filtered bioslurry + biofertilizer nutrigation (6.0%, 110.09 mg100g^{-1}), followed by drip fertigation at 100% RDF (5.67%, 87.8 mg100g^{-1}).Therefore, it could be concluded that, even though yield and uptake were highest in mineral fertigation, curd quality parameters like total sugars, ascorbic acid content were superior in bioslurry/biofertilizer treatments.

Keywords: *Bioslurry, Biofertilizer, Filtration, Drip irrigation, NPK-uptake, Curd quality, Fertigation, Organic farming, crop productivity.*

INTRODUCTION

The demand for organic foods has increased in present scenario, because of the increased consumer knowledge about the negative impacts of producing crop by using synthetic (chemicals)fertilizers, pesticides, etc in agriculture. Chemical driven agricultural practices deteriorate the soil health, which is major nutrient medium for crop nutrient uptake [1],[3],[23].

Corresponding Author: **Susama Sudhishri*

DOI: https://doi.org/10.21276/AATCCReview.2025.13.01.138

Therefore, the global food production system must undergo significant change to meet the challenges of feeding a growing population and reducing environmental concerns [8],[19]. Compared to conventional farming, organic farming has the potential to improve soil quality, sustain crop productivity, and improve the quality of crop produce [3]. The initiation of the 'Green Revolution' in India led to the utilization of synthetic fertilizers, which supply easily available nutrients, notably nitrogen (N), phosphorous (P), and potassium (K), to plants. This approach resulted in the excessive application of synthetic chemical fertilizers, leading to salt accumulation in the soil, which adversely affects soil health [12]. These effects include the elimination of beneficial microbes, a reduction in soil fertility, and a decrease in the quantity of organic matter in the soil. Therefore, Organic farming has been promoted as an effective approach to sustainable agriculture that decreases its dependency on chemical fertilizers and eventually improves the use of naturally available renewable organic fertilizers. Organic fertilizers derived from agricultural byproducts, such as straw, compost, farmyard manure, green manure, and residual biogas slurry, are utilized in this agricultural system [10],[13]. Bioslurry derived from the anaerobic digestion process comprises organic-N, micronutrients in the form of mineral elements, and bioactive components, including humic acid, vitamins, and hormones [13],[29]. Organic fertilizers generally act as slow-release fertilizers because they release nutrients gradually over an extended period [15]. Microorganisms are involved in the degradation of various organic waste constituents by secreting various hydrolytic enzymes. Therefore, a class of microorganisms called "bio-decomposers," which includes fungi, bacteria, and other microorganisms, assists in the faster breakdown of biomass and consequently improves the availability of nutrients by breaking down complex organic materials into simpler ones [7],[21]. Similarly, biofertilizer contains living microorganisms, that are involved in various soil nutrient cycle mechanisms such as N_2-fixation, P and K solubilization, which enhance soil fertility, increase crop yields, and improve nutrient uptake [22]. India's food and nutrigation status depends significantly on vegetables. Cauliflower is a superfood since it is high in protein, carbohydrates, minerals, vitamins A and C, low in fat, and high in fiber. It also protects human health because it is packed with antioxidants, polyphenols, and phytochemicals that lower the risk of aggressive prostate cancer [28]. Fertilizer and water have been considered to be the most crucial inputs for increasing productivity. Drip irrigation is an incredibly water application method that delivers water and nutrients directly to plant root system and this eliminates the loss of water due to evaporation and leaching of nutrients from root zone which is common in flood irrigation and ensures the high-water distribution and nutrient-use efficiency [17].To meet the crop's water and nutritional needs at different stages of growth, water and fertilizer must be applied effectively through drip fertigation, at a low rate to the area surrounding the plant root zone directly in readily available forms [18],[30]. The study's novelty was the use of chemical fertilizers and bioslurry as a source of nutrients. The filtrate liquid was used for fertigation in crop through drip system (known as nutrigation) after the bioslurry was incubated with a bio-decomposer and filtered through a cascade filter.

Materials and Methods

Study site

This field experiment was conducted at the research farm of the Water Technology Centre, ICAR-Indian Agricultural Research Institute (IARI), New Delhi (28.63° N, 77.16° E), India during the *rabi* season of 2023-24. The samples of bioslurry were collected from the biogas plant at the Integrated Farming System (IFS) in the Division of Agronomy, IARI, New Delhi. Following that, the biogas slurry was examined using standard methods at the Soil and Plant Quality Laboratory, Water Technology Centre, ICAR-IARI, New Delhi. Bio-decomposing agent Pusa Decomposer and biofertilizers (*Azotobacter, PSB, potassium mobilizing bacteria*) were procured from Division of Microbiology, ICAR-IARI, New Delhi.

Table 1 Chemical composition of bioslurry before and after filtration

Parameters	Before Filtration	After Filtration
Total N (%)	4.4	0.0107
Total P (%)	1.42	0.0076
Total K (%)	0.47	0.0048
Organic carbon (%)	44.31	0.35
Fungal population	55	13
Bacterial population	52	9
Glucose (%)	92.85	15.35

Experimental design and statistical analysis

Bioslurry was used as an organic nutrient source for the test crop. After collection of bioslurry from the IFS in the Division of Agronomy, IARI, New Delhi, the bioslurry was treated with Pusa Decomposer and incubated upto 21 days for nutrient improvement. After 21 days of Incubation period, the treated slurry was filtered with a cascade filter system. The filtered bioslurry was applied to crop using the drip system. The experimental treatments included two Irrigation levels viz, drip irrigation at 80% ETc (I_1) and drip irrigation at 100% ETc (I_2) and six nutrigation levels including filtered slurry nutrigation alone (N_1), filtered bio slurry + biofertilizer nutrigation (N_2), filtered bioslurry + biofertilizer soil application (N_3), filtered bioslurry + biofertilizer seed treatment (N_4), drip fertigation at 100% RDF (N_5), control: only drip Irrigation + no fertigation (N_6). Daily crop evapotranspiration (ETc) was estimated by Penman Monteith method using CROPWAT software taking daily weather data from the Division of Agricultural Physics, ICAR-IARI, New Delhi. A three-time replicated split plot design was used in conducting the field experiment, soil type of research field was sandy loamy. The cascade filter system consisted of three polyethylene tanks with a surface area of 1.96 m^2 and a volume of 200 L each. These tanks are positioned at different heights and filled with a mixture of pebbles, gravel, and sand in a ratio of 3:1:1.5. The cauliflower crop fertilizer requirement is 120:60:60 kg ha^{-1} and the crop were fertilized at weekly interval during the crop growing period.

Plant uptake and curd nutrient analysis

Using the Kelplus analyser, the micro Kjeldhal method was used to determine the N-content of powdered plant samples at 30 and 45 days after planting, as well as samples of leaves and curd at harvest. The phosphorus content of the curd and plant samples digested with di-acid was measured using vanado-molybdous phosphoric acid. The spectrometer was used to measure the intensity of the yellow colour that developed at 420 nm. A flame photometer was used to measure the K-content of the leaves and curd in the di-acid [14]. After harvest cauliflower curd quality parameters were assessed by determining ascorbic acid and vitamin-C content. Ascorbic acid content in cauliflower curd was estimated by 2,6-dichloro-indophenol method [2]. Total sugars in cauliflower curd was estimated by phenol-sulphuric acid method [6].

Result& Discussion

Results

Scheduling of irrigation of cauliflower crop through drip irrigation system improves the crop growth and yield compared to surface irrigation. This might be due to the optimal moisture levels near the root zone during the crop's growth period favoured the readily available nutrients to the plant. These findings coincided with [17],[16],[26],[27], which indicated that nutrient uptake increased following an increase in irrigation level.

Curd yield

Drip irrigation (Table 4) scheduled at 100% ETc (I_2) recorded highest curd yield (16.3 t ha^{-1}) and irrigation level 80% ETc (I_1) recorded curd yield 15.1 t ha^{-1}, which was comparable with 100% ETc. These results conformed with [17],[18],[26],[27], who reported that curd yield increased with higher irrigation levels. Drip fertigation at 100% RDF (Table 4) recorded significantly higher curd yield (21.25 t ha^{-1}) among the other treatments. Bioslurry nutrigation with biofertilizer drip/soil application recorded curd yield (17.12 and 17.05 t ha^{-1}). Bioslurry nutrigation with biofertilizer seed treatment recorded curd yield 15.47 t ha^{-1} and bioslurry nutrigation alone recorded curd yield 13.80 t ha^{-1}. The control treatment recorded the lowest curd yield (9.43 t ha^{-1}). These results followed the trend of earlier workers, who reported that the split application of fertigation with drip may have contributed to the higher nutrient content in the fertilizer treatment with 100% RDF. But coming to the bioslurry nutrigation and biofertilizer treatments there might be due better soil health conditions and mineralization of organic matter by biofertilizers which applied through drip nutrigation. This may result in gradual supply of nutrients like nitrogen, phosphorous, potassium required by the crop during the growth period, that may account for higher nutrient uptake in bioslurry nutrigation treatments [5],[22],[16],[4],[30]. Some other research works reported that the reason for low yield from organic manure treated crop, compared to chemical fertilizer treatments. This might be due to slow organic matter mineralization, unlike the readily available nutrients in the case of chemical fertilizer [11].

Nitrogen uptake

Different nutrigation levels had a significant impact on N-uptake following bioslurry nutrigation, whereas irrigation levels had a non-significant impact (Table 1). Highest N-uptake was observed during the 30, 45 DAT, and harvest (leaf, curd) growing stages when drip irrigation was scheduled at 100% ETc (7.62, 36.58, 112.5, and 78.03 kg ha^{-1}). However, N-uptake at 80% ETc was also noted to be significantly comparable to that at 100% ETc irrigation. As the N-uptake increased when there were increased irrigation levels. Significantly higher N-uptake was recorded during the 30, 45DAT, Harvest (leaf, curd) growing stages 11.45, 47.73, 143.28, and 103.62 kg ha^{-1}at 100% RDF treatment compared to other nutrigation treatments. The latter was followed by the nutrigation treatments filtered bioslurry + biofertilizer soil application and filtered bio slurry + biofertilizer nutrigation, which recorded 8.07, 37.51, 123.87, 87.32 kg ha^{-1} and 7.65, 36.98, 125.2, and 87.1 kg ha^{-1}, respectively. Both filtered bioslurry + biofertilizer soil application and filtered bio slurry + biofertilizer nutrigation treatments are significantly on par with each other. filtered bioslurry + biofertilizer seed treatment and filtered slurry nutrigation alone treatments recorded 7.0, 34.55, 114.49, 76.92 kg ha^{-1} and 6.4, 34.49, 98.80, 67.42 kg ha^{-1} in leaf, curd respectively at 30, 45, harvest. At harvest, filtered bioslurry + biofertilizer seed treatment recorded significantly higher nitrogen uptake compared to filtered slurry nutrigation alone treatment. Control treatment recorded the lowest N-uptake in all plant parts and at all growth stages.

Phosphorous uptake

During the cauliflower growing stages, 30, 45DAT, and harvest (leaf, curd), drip irrigation scheduled at 100% ETc recorded significantly higher P-uptake of 0.32, 3.31, 21.85, and 24.25 kg ha^{-1}, respectively (Table 2). However, P-uptake at 80% ETc was found to be comparable to that at 100% ETc irrigation level. Fertigation treatment 100% RDF recorded significantly higher P-uptake (0.47, 4.5, 27.16, 31.4 kg ha^{-1}), followed by nutrigation treatments filtered bioslurry + biofertilizer soil application and filtered bio slurry + biofertilizer nutrigation, which recorded 0.36, 3.49, 25.84, 27.11kg ha^{-1} and 0.35, 3.47, 25.69, and 27.08 kg ha^{-1} P-uptake respectively. The control treatment recorded the lowest P-uptake (0.09, 0.79, 8.87, 6.93 kg ha^{-1}).

Potassium uptake

Highest K-uptake (Table 3) was observed during the 30, 45 DAT, and harvest (leaf, curd) growing stages 6.1, 41.87, 131.1, and 48.22 kg ha^{-1}, respectively, when drip irrigation was scheduled at 100% ETc. However, K-uptake at 80% ETc was found to be comparable to that at 100% ETc irrigation. Potassium uptake for the different nutrigation treatments during the 30, 45DAT, harvest (leaf, curd) growing stages, drip fertigation scheduled at 100% RDF recorded the significantly higher K-uptake (8.51, 51.92, 157.85, and 60.61 kg ha^{-1}). This was followed by nutrigation treatments filtered bioslurry + biofertilizer soil application and filtered bio slurry + biofertilizer nutrigation, which recorded 6.69, 47.06, 145.41, 54.38 kg ha^{-1} and 6.63, 46.50, 144.77, and 53.61 kg ha^{-1}, K-uptake respectively. The control treatment recorded the lowest K-uptake.

NPK uptake

The NPK-uptake of cauliflower results followed the trend of earlier workers, who reported that as soon as the fertilizers are applied in the recommended dosage based on crop needs, the nutrients are readily available in the crop root zone for growth and development, which is reflected in nitrogen, phosphorous, potassium uptake for chemical fertilizers treatments [17],[18],[26],[27],[16]. Application of the organic amendments, the soil's organic matter content may have increased, leading to an increase of nutrients in the soil root zone [5,22]. Breaking down of organic matter in the bioslurry, by biofertilizers (*Azotobacter, PSB and potassium mobilizing bacteria*), which involved in nutrient cycles such as nitrogen availability, phosphorous solubility, potassium mobilization. This may have contributed to the higher availability of nutrients by enabling the solubilization of phosphorous and potassium, nitrogen progressively during the crop growing period, which enhances the nutrient uptake [3],[5].

Curd Quality Parameters

Drip irrigation at 100% ETc irrigation (Table 4) recorded the highest total sugars 5.07 (%) and ascorbic acid 98.16 (mg $100g^{-1}$) content were which comparable with 80% ETc irrigation, which recorded total sugars content (4.7%) and ascorbic acid content (91.34 mg$100g^{-1}$). These results conformed with [26], who reported that the total sugars, ascorbic acid content increased at higher irrigation levels. Cauliflower curd under bioslurry nutrigation and biofertilizer application through drip/soil application recorded superior quality total sugars, ascorbic acid content than the chemical fertigations (100% RDF) treatment. Highest levels of ascorbic acid (111.49, 110.09 mg$100g^{-1}$) and total sugars (6.02, 6%) were recorded by filtered bioslurry + biofertilizer soil application, filtered bio slurry + biofertilizer nutrigation treatments, which were significantly on par with each other. Drip fertigation at 100% RDF treatment recorded ascorbic acid content (87.87 mg $100g^{-1}$) and total sugar content (5.67%), while the control treatment recorded the lowest total sugars (0.88%) ascorbic acid content (62.84 $mg100g^{-1}$).These results were following [3,4,5,16], reported that the total sugars, ascorbic acid content increased due to the mineralization of organic matter and biofertilizer at different rates, providing the different levels of organic nutrients which are otherwise in unavailable condition in organic matter. The higher distribution of younger curds displaying the higher total sugars, and ascorbic acid content than the older fruits. This supports the bioslurry/biofertilizer treatments had a higher percentage of younger curds compared to mineral fertilizer grown crops [24],[4].

Conclusions

The results indicate that application of bio-decomposer treated filtered bioslurry along with biofertilizer improves the nitrogen phosphorous, potassium uptake of cauliflower crop. Even though the uptake is less than the drip fertigation at 100% RDF, nutrient quality of cauliflower grown under bioslurry nutrigation with biofertilizer drip/soil application is superior to the chemical fertilizer treatments. Thus, the consumption of nutritionally superior quality curds has more health benefits than the chemically treated vegetables by reducing risk of many chronic diseases. Future research should explore the long-term impact of bioslurry nutrigation on soil health, microbial activity, and yield sustainability across different crops and agro-climatic regions. Additionally, pilot-scale implementations can support the broader adoption of these practices by farmers.

Acknowledgements

The authors are thankful to the Director and Dean of ICAR-IARI, New Delhi for granting the fellowship to S.G and to the Project Director and Professor of Water Technology Centre, ICAR-IARI, New Delhi for providing the necessary facilities and project staff during the research program.

Author contributions

All the authors contributed intellectual input and research assistance to this study and manuscript preparation. S.S. Conceptualization; S.G., S.S., S. G. and L.S. investigation; S.G., S.S., L.S, A.S, K.L., M.K., R.K., R.B., A.B., K.K, A.D, S.G., R.Y Methodology, validation, formal analysis and data curation, S.G., S.S., L.S. R.Y., S G., A.D. and S.K. writing; S.G., S.S., L.S. R.Y., A.D., S.K., A.S., M.K., K.L R.K., A.B. review and editing; S.S. supervision

Conflict of Interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Data Availability Statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries are can be directed to the corresponding author.

Table 1: Nitrogen Uptake ($kgha^{-1}$) of cauliflower at different days aftertransplanting as influenced by varied drip irrigation and nutrigation levels

Treatments	30 DAT	45 DAT	Harvest (Leaf)	Harvest (Curd)	Total
Irrigation Levels (Main Plots)					
DI-80% ETc-I_1	6.87	34.12	109.54	73.42	182.96
DI-100% ETc-I_2	7.62	36.58	112.5	78.03	190.52
CD (P=0.05)	**1.80**	**4.78**	**8.38**	**6.70**	**11.33**
Nutrigation Levels (Sub Plots)					
FBN-N_1	6.4	31.49	98.8	67.42	166.22
FB+BN-N_2	7.65	36.98	125.2	87.1	212.3
FB+BSA-N_3	8.07	37.51	123.87	87.32	211.19
FB+BST-N_4	7	34.55	114.49	76.92	191.41
DF 100%RDF-N_5	11.45	47.73	143.28	103.62	246.9
Control-N_6	2.9	23.88	60.49	31.97	92.46
CD (P=0.05)	**1.51**	**4.36**	**4.90**	**5.14**	**7.01**

***DI**:Drip Irrigation, **FBN**:Filtrered bioslurry nutrigation, **FB+BN**:Filtered bioslurry + biofertilizer nutrigation, **FB+BSA**: Filtered bioslurry + biofertilizer soil application, **FB+BST**: Filtered bioslurry + biofertilizer seed treatment, **Control**: Drip irrigation + No Fertigation,**DAT**: Days After Transplanting, **RDF**: Recommended Dose of Fertilizer*

Table 2: Phosphorous Uptake ($kgha^{-1}$) of cauliflower at different days aftertransplanting as influenced by varied drip irrigation and nutrigation levels

Treatments	30 DAT	45 DAT	Harvest (Leaf)	Harvest (Curd)	Total
Irrigation Levels (Main Plots)					
DI-80% ETc-I_1	0.28	2.7	20.33	21.70	42.03
DI-100% ETc-I_2	0.32	3.31	21.85	24.25	46.11
CD (P=0.05)	**0.09**	**0.56**	**2.94**	**6.12**	**8.90**
Nutrigation Levels (Sub Plots)					
FBN-N_1	0.24	2.69	17.52	20.92	38.47
FB+BN-N_2	0.35	3.47	25.69	27.08	52.77
FB+BSA-N_3	0.36	3.49	25.84	27.11	52.92
FB+BST-N_4	0.3	3.1	21.46	24.48	45.94
DF 100%RDF-N_5	0.47	4.5	27.16	31.4	58.56
Control-N_6	0.09	0.79	8.87	6.93	15.80
CD (P=0.05)	**NS**	**0.84**	**4.27**	**4.42**	**8.35**

***DI**:Drip Irrigation, **FBN**: Filtrered bioslurry nutrigation, **FB+BN**: Filtered bioslurry + biofertilizer nutrigation, **FB+BSA**: Filtered bioslurry + biofertilizer soil application, **FB+BST**: Filtered bioslurry + biofertilizer seed treatment, **Control**: Drip irrigation + No Fertigation, **DAT**: Days After Transplanting, **RDF**: Recommended Dose of Fertilizer*

Table 3: Potassium Uptake (kgha[-1]) of cauliflower at different days aftertransplanting as influenced by varied drip irrigation and nutrigation levels

Treatments	30 DAT	45 DAT	Harvest (Leaf)	Harvest (Curd)	Total
Irrigation Levels (Main Plots)					
DI-80% ETc-I_1	5.45	38.17	126.75	43.81	170.56
DI-100% ETc-I_2	6.1	41.87	131.1	48.22	179.33
CD (P=0.05)	**1.41**	**3.60**	**3.55**	**9.41**	**9.07**
Nutrigation Levels (Sub Plots)					
FBN-N_1	5.04	36.06	129.6	43.49	173.09
FB+BN-N_2	6.63	46.50	144.77	53.61	198.39
FB+BSA-N_3	6.69	47.06	145.41	54.38	199.79
FB+BST-N_4	6.07	39.5	136.41	48.75	185.15
DF 100%RDF-N_5	8.51	51.92	157.84	60.61	218.46
Control-N_6	1.74	19.11	59.52	15.27	74.79
CD (P=0.05)	**1.19**	**5.85**	**7.50**	**5.67**	**9.0**

DI:*Drip Irrigation,* ***FBN***: *Filtrered bioslurry nutrigation,* ***FB+BN***: *Filtered bioslurry + biofertilizer nutrigation,* ***FB+BSA***: *Filtered bioslurry + biofertilizer soil application,* ***FB+BST***: *Filtered bioslurry + biofertilizer seed treatment,* ***Control***: *Drip irrigation + No Fertigation,* ***DAT***: *Days After Transplanting,* ***RDF***: *Recommended Dose of Fertilizer*

Table 4: Total Sugars and Ascorbic acid of cauliflower at different days aftertransplanting as influenced by varied drip irrigation and nutrigation levels

Treatments	Total Sugars (%)	Ascorbic acid (mg/ 100g)	Yield (t/ha)
Irrigation Levels (Main Plots)			
DI- 80% ETc-I_1	4.7	91.34	15.10
DI-100% ETc-I_2	5.07	98.16	16.33
CD (P=0.05)	**0.26**	**11.62**	**1.57**
Nutrigation Levels (Sub Plots)			
FBN-N_1	5.28	97.33	13.80
FB+BN-N_2	6.00	110.09	17.05
FB+BSA-N_3	6.02	111.49	17.12
FB+BST-N_4	5.47	98.86	15.47
DF 100%RDF-N_5	5.67	87.87	21.25
Control-N_6	0.88	62.84	9.43
CD (P=0.05)	**0.40**	**5.15**	**1.60**

DI:*Drip Irrigation,* ***FBN***: *Filtrered bioslurry nutrigation,* ***FB+BN***: *Filtered bioslurry + biofertilizer nutrigation,* ***FB+BSA***: *Filtered bioslurry + biofertilizer soil application,* ***FB+BST***: *Filtered bioslurry + biofertilizer seed treatment,* ***Control***: *Drip irrigation + No Fertigation,* ***DAT***: *Days After Transplanting,* ***RDF***: *Recommended Dose of Fertilizer*

References

1. Al-Suhaibani, N, Selim M, Alderfasi A, El-Hendawy S, (2020) Comparative performance of integrated nutrient management between composted agricultural wastes, chemical fertilizers, and biofertilizers in improving soil quantitative and qualitative properties and crop yields under arid conditions. *Agronomy10*(10):1503.

2. AOAC (1970) Official methods of Analysis. 11th Edition. Association Official Analytical Chemist, Washington DC.

3. Barański M, Średnicka-Tober D, Volakakis N, Seal C, Sanderson R, Stewart GB, Benbrook C, Biavati B, Markellou E, Giotis C and Gromadzka-Ostrowska J, (2014) 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 Nutrigation*, *112*(5): 794-811.

4. Barzee TJ, Edalati A, El-Mashad H, Wang D, Scow K and Zhang R, (2019) Digestate biofertilizers support similar or higher tomato yields and quality than mineral fertilizer in a subsurface drip fertigation system. *Frontiers in Sustainable Food Systems*, *3*: 58.

5. Das A, Patel DP, Kumar M, RamkrishnaGI, Mukherjee A, Layek J, Ngachan SV, Buragohain J, (2017) Impact of seven years of organic farming on soil and produce quality and crop yields in eastern Himalayas, India. *Agriculture, Ecosystems &Environment 236*: 142-153.

6. Dubois M, Gilles KA, Hamilton JK, Rebers PA and Smith FAJN, (1951) A colorimetric method for the determination of sugars. *Nature*, *168*(4265):167-167.

7. Dudhade DD, and Gadakh SS, (2021) Effect of Consortium of Azotobacter, Phosphate Solubilizing Bacteria and Potash Mobilizing Bacteria on Yield of rabi Sorghum. *International Journal of Current Microbiology and Applied Sciences 10*:7.

8. Foley JA, Ramankutty N, Brauman KA, Cassidy ES, Gerber JS, Johnston M, Mueller ND, O'Connell C, Ray DK, West PC and Balzer C, (2011) Solutions for a cultivated planet. *Nature*, *478*(7369): 337-342.

9. Gadekar TK, (2024) Effect of azotobacter, P- solubilizing and K- mobilising bacteria on growth and yield of aloe vera *(Aloe barbadensis Miller)* (Doctoral dissertation, MPKV, Rahuri).

10. Gomez I, Thivant L (2017) Training manual for organic agriculture. *Scientific Publishers-UBP*.

11. Hartz TK, Smith R and Gaskell M, (2010) Nitrogen availability from liquid organic fertilizers. *HortTechnology*, *20*(1):169-172.

12. Ishii K, Fukui M, Takii S (2000) Microbial succession during a composting process as evaluated by denaturing gradient gel electrophoresis analysis. *Journal of Applied Microbiology*89, (5):768-777.

13. Iyengar SR, Bhave PP (2006) In-vessel composting of household wastes. *Waste Management* 26, (10):1070-1080.

14. Jackson ML, (1973) Soil chemical analysis prentice hall of India private limited. *New Delhi*, *498*.

15. Jacob S and Banerjee R, (2017) Nutrient enrichment of organic manure through biotechnological means. *Waste and biomass valorization*, *8*: 645-657.

16. Kalita P, Thakuria RK, Deka B and Choudhary H, (2022) Effect of varying drip irrigation levels and NPK fertigation on nutrient uptake, root characteristics, physiological behavior and head quality of broccoli (Brassica oleracea var. italica) in warm humid climatic condition of Assam. *Pharma Innovation*, *12*: 563-569.

17. KhilendraK, (2017) Water and nutrient management studies on cauliflower (*Brassica oleracea var. botrytis l.*) under drip environment (Doctoral Dissertation, Indira Gandhi Krishi Vishwavidhyalaya, Raipur).

18. Kishor N,(2019) Standardization of drip fertigation levels in midseason cauliflower (*Brassica oleracea var. botrytis* L.). *M.Sc (Ag) Thesis.* ICAR-Indian Agricultural Research Institute (Indian Council of Agricultural Research) New Delhi – 110012.

19. Lal R, (2020) Advancing climate change mitigation in agriculture while meeting global sustainable development goals. *Soil and water conservation: 75*.

20. Liu, J., Xu, X. H, Li, H. T., Xu, Y. (2011) Effect of microbiological inocula on chemical and physical properties and microbial community of cow manure compost. *Biomass and Bioenergy*35: 3433-3439

21. Mącik M, Gryta A and Frąc M, (2020) Biofertilizers in agriculture: An overview on concepts, strategies and effects on soil microorganisms. *Advances in agronomy 162*: 31-87.

22. Oliveira RC, Luz JMQ, Lana RMQ, Queiroz, AA and Bertoldo DL, (2020) Biofertilizer in leaf and drip applications: an alternative to increase tomato productivity. *Comunicata Scientiae*, *11*, 3376-3376.

23. Reeve JR, Hoagland LA, Villalba JJ, Carr PM, Atucha A, Cambardella C, Davis DR and Delate K, (2016) Organic farming, soil health, and food quality: considering possible links. *Advances in agronomy 137*: 319-367.

24. Renquist AR and Reid JB, (1998) Quality of processing tomato (*Lycoperscion esculentum*) fruit from four bloom dates in relation to optimal harvest timing. *New Zealand journal of crop and horticultural science*, *26*(2): 161-168.

25. Sahu PK and Brahmaprakash GP, (2016) Formulations of biofertilizers–approaches and advances. *Microbial inoculants in sustainable agricultural productivityFunctional Applications* 2: 179-198.

26. Shams AS and Farag AA, (2019) Implications of water stress and organic fertilization on growth, yield and water productivity of cauliflower (Brassica oleracea var. botrytis, L.). *Journal of Plant Production10*(10): 807-813.

27. Singh Ajeet, Sharma SK and Chopra, R.A.H.U.L., 2017. Effect of drip fertigation scheduling on yield and economics of cauliflower (Brassica oleracea var. botrytis) and chilli (Capsicum annuum L.). *Annals of Plant and Soil Research*, *19*(2), 137-142.

28. Statistics Horticulture, (2018) Horticultural statistics at a glance. *Horticulture Statistics Division, Department of Agriculture & Cooperation. Ministry of Agriculture & Farmer's Welfare, Government of India*, *458*.

29. Yadav, R, Sudhishri, S, Khanna, M, Lal, K, Dass, A, Kushwaha, HL, Bandyopadhyay, K, Dey, A, Kushwah, A and Nag RH, (2023) Temporal characterization of biogas slurry: a pre-requisite for sustainable nutrigation in crop production. *Frontiers in Sustainable Food Systems*, *7*: 1234472.

30. Yadav, R, Sudhishri, S, Khanna, M, Lal, K, Dass, A, Kushwaha, HL, Bandyopadhyay, K, Suman, A, Singh, A, Singh, RK and Singh, R, (2024) A Greener Approach to Spinach Farming: Drip Nutrigation with Biogas Slurry Digestate. *Agronomy*, *14*(4): 681.

