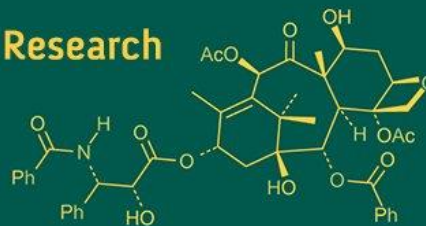


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(6): 735-740
www.biochemjournal.com
Received: 15-03-2026
Accepted: 18-04-2026

Romil Raman
M.Sc. (Ag.), Department of Horticulture (Vegetable Science), Faculty of Agricultural Sciences and Allied Industries, Rama University, Mandhana, Kanpur, Uttar Pradesh, India

Jitendra Kumar
Assistant Professor, Department of Horticulture (Vegetable Science), Faculty of Agricultural Sciences and Allied Industries, Rama University, Mandhana, Kanpur, Uttar Pradesh, India

Corresponding Author:
Jitendra Kumar
Assistant Professor, Department of Horticulture (Vegetable Science), Faculty of Agricultural Sciences and Allied Industries, Rama University, Mandhana, Kanpur, Uttar Pradesh, India

Effect of integrated nutrient management on growth and yield of Cauliflower (*Brassica oleracea* var. *botrytis*)

Romil Raman and Jitendra Kumar

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i6Si.8695>

Abstract

Cauliflower (*Brassica oleracea* var. *botrytis* L.) stands as a cornerstone of the Indian vegetable sector, valued for its significant economic contribution and dense nutritional profile. However, achieving high productivity in this crop is heavily contingent upon balanced fertilization, as the excessive use of synthetic inputs increasingly threatens soil vitality and long-term crop sustainability. In order to find a solution, a field study was conducted in the year 2025-2026 Rabi season on Horticulture Research Farm for finding out the efficiency of integrated nutrient management techniques. In this, a randomized block design (RBD) with eight treatments and three replicates, involving combinations of RDF, organic manures (vermicompost and FYM) along with the use of bio-fertilizer (Azotobacter) was adopted. The main objectives of the study were the evaluation of impact of integrated nutrient management (INM) and bio-fertilizers on the growth and yield related characteristics of cauliflower.

According to the results of the current study, Treatment T₈ (75% RDF + 25% Vermicompost + Azotobacter) recorded the best effects on growth attributes, including the highest number of leaves per plant (24.00) and the longest leaf length (52.03 cm) at 90 DAT. This treatment also showed superior performance in lateral leaf expansion, facilitating a robust photosynthetic canopy essential for high-quality curd development.

Regarding yield and quality parameters, T₈ (75% RDF + 25% Vermicompost + Azotobacter) achieved the maximum curd equatorial diameter (18.51 cm), greatest curd depth (10.50 cm) and the highest yield per hectare (397.73 q), while the significantly minimum yield was observed in the control (276.93 q). In terms of quality, T₈ (75% RDF + 25% Vermicompost + Azotobacter) produced the highest ascorbic acid content (78.86 mg/100g) and the highest total sugars (2.50%). This suggests that the integration of *Azotobacter* with organic amendments at a 75% inorganic nutrient level acts as a viable sustainable alternative for high-quality cauliflower production with reduced chemical inputs.

Keywords: Azotobacter, Bio-fertilizers, Cauliflower, FYM, Integrated Nutrient Management (INM), Quality, Vermicompost and Yield

Introduction

Cauliflower (*Brassica oleracea* L. var. *botrytis*) is a premier cruciferous vegetable, ranking fifth in global importance within the *Brassicaceae* family and serving as a cornerstone of Indian horticulture (Mpumi *et al.*, 2020) [13]. Botanically, its edible "curd" represents an ontogenetic transitional stage featuring a highly condensed, pre-floral meristem (Singh *et al.*, 2021) [25]. Beyond its high commercial value, cauliflower is a critical source of dietary fiber, essential micronutrients and potent bioactive compounds most notably glucosinolates and flavonoids which contribute significant antimicrobial, antioxidant and anticarcinogenic properties to human nutrition (Raiola *et al.*, 2018; Fusari *et al.*, 2020) [19, 7]. As per the advance estimate for 2025, the national production area covered nearly 503,000 hectares, with a total production of 10,290,000 tons, along with an average production efficiency of 19.13 tons per hectare. As far as the production of cauliflower is concerned in the region of Uttar Pradesh, 19,722 hectares of land was utilized for its production in 2024 with a total production of 53,646,573 tons (Anonymous, 2025) [4].

However, sustaining optimal curd yield and quality faces steep agronomic challenges. Because cauliflower development relies on rapid, high-density nutrient extraction across distinct vegetative and reproductive phases, producers frequently resort to the indiscriminate application of straight synthetic nitrogenous fertilizers (Ojetayo *et al.*, 2011; Kaur & Mal,

2018)^[15, 11]. While excessive inorganic nitrogen boosts immediate vegetative biomass, it systematically compromises post-harvest quality, reduces shelf life, suppresses secondary metabolite synthesis and triggers physiological disorders like "buttoning" or "blindness" (Ojetayo *et al.*, 2011)^[15]. Furthermore, this intensive reliance on synthetic inputs causes severe ecological degradation, including soil acidification, rhizosphere depletion and environmental pollution via nitrate leaching (Singh *et al.*, 2014; Aasfar *et al.*, 2021)^[23, 1].

To mitigate these drawbacks and ensure edaphic sustainability, transitioning toward Integrated Nutrient Management (INM) is essential. Because neither synthetic fertilizers nor organic amendments alone can satisfy the rapid nutrient cycling demands of intensive vegetable production, a combined strategy is required (Jangir *et al.*, 2021)^[9]. The synergistic application of

Farmyard Manure (FYM) and vermicompost improves soil physical architecture, enhances moisture retention and provides a balanced array of macro- and micronutrients supplemented by plant growth-promoting regulators (Prasad & Sinha, 2000; Rehman *et al.*, 2023)^[18, 20]. When coupled with biofertilizers like *Azotobacter* which fix atmospheric nitrogen and synthesize essential phytohormones, the reliance on chemical inputs can be safely reduced by 10% to 20% without sacrificing yield (Aasfar *et al.*, 2021)^[1].

While the general principles of INM are established, there remains a critical need to design regionally optimized treatment combinations that maximize economic returns and curd quality within the specific agro-climatic constraints of Uttar Pradesh. Documenting these interactions is vital for local sustainable agricultural practices.

Materials and Methods

The *rabi* field experiment evaluating the "Effect of integrated nutrient management on growth, yield and quality Parameter of Cauliflower (*Brassica oleracea* var. *botrytis*)" was conducted during the 2025-26 season at the Primary Experimental Station of Rama University, situated in Kanpur (U.P.). The site portrays the typical physiographic features of the central Gangetic alluvial belt and the semi-arid to sub-tropical agroclimatic characteristics of the Central Plain Zone of Uttar Pradesh. The experimental zone is mapped by geographic coordinates extending from 25°34' N to 26°11' N latitudes and 81°19' E to 82°27' E longitudes, lying at an average elevation of 137 meters above mean sea level. Mechanical and chemical characterization of the surface soil (0-15 cm depth) revealed a sandy loam texture with a pH level of 7.2, depicting a neutral-to-slightly alkaline reaction and an electrical conductivity of 0.27 dS/m. The substrate was characterized by a deficit in organic carbon, which was found to be low at 0.51%. Initial nutrient profiling recorded an available nitrogen content of 171.48 kg N/ha and an available phosphorus content of 17.60 kg P/ha, while the available potassium was maintained at 216.40 kg K/ha. Meteorological data logged throughout the crop cultivation period from October 2025 to March 2026 indicated highly stable relative humidity and fluctuating thermal conditions, with a total cumulative rainfall of 7.54 mm. The experiment consisted eight treatments viz. T₁: Control, T₂: 100% RDF (175: 75 :70), T₃: 75% RDF + 25% FYM, T₄: 50% RDF + 50% FYM, T₅: 75% RDF + 25% Vermicompost, T₆: 75% RDF + 25% FYM + *Azotobacter*, T₇: 50% RDF + 50% FYM +

Azotobacter, T₈: 75% RDF + 25% Vermicompost + *Azotobacter* which was analyzed in randomized block design with three replications. The experimental field was subjected to deep ploughing followed by harrowing to achieve a well-pulverized, fine tilth. Prior to transplanting, raised nursery beds measuring 3 m × 1 m at an elevation of 20 cm were meticulously prepared. To mitigate soil-borne pathogens, seeds of cauliflower variety 'Pusa Snowball K-1' were treated with the systemic fungicide Carbendazim (Bavistin) before sowing. For specified biological treatments, *Azotobacter* biofertilizer was soil-applied at a rate of 2 kg/ha by pre-mixing the inoculant with organic manure. Uniform, healthy seedlings were carefully transplanted during the evening hours of October 25, 2025, at a standardized spacing of 60 cm between rows and 45 cm between plants. A consistent plant population was maintained through gap-filling operations executed one-week post-transplanting. A systematic irrigation schedule was maintained at 15-day intervals and a total of five manual weeding operations were rigorously executed at 15-day intervals up to 80 days post-transplanting. The crop was supplied with a standardized recommended inorganic nutrient dose of 175 kg of nitrogen (N), 75 kg of phosphorus (P₂O₅) and 70 kg of potassium (K₂O) per hectare utilizing Urea, Single Super Phosphate and Muriate of Potash. The fertilization strategy involved the basal application of the entire quantum of phosphorus and potassium alongside fifty percent of the total nitrogen at transplanting, while the remaining half of the nitrogen was top-dressed 30 days post-transplanting. Organic amendments consisting of farmyard manure (FYM) and vermicompost were incorporated basally in accordance with specific treatment requirements, while foliar sprays of Acephate and Dichlorvos were applied to manage aphid vectors. Crucial observations concerning vegetative growth (at 30, 60 and 90 DAT), curd yield and quality parameters were documented from five tagged, representative plants within each treatment replicate. Statistical analysis of the experimental data was conducted using the Analysis of Variance (ANOVA) technique as defined by Panse and Sukhatme (1985) and the significance of the treatment differences was evaluated using the "F" test at a 5% probability level.

Results and Discussion

Effect of integrated nutrient management on growth attributes of cauliflower

The data on growth traits of cauliflower presented in the table 1 indicates the significant effects of integrated nutrient management regimes. Plant vegetative parameters, including plant height and the number of leaves, varied significantly across different treatments. The highest plant height was consistently recorded in treatment 75% RDF + 25% Vermicompost + *Azotobacter* (T₈), observing a maximum height of 62.03 cm, which significantly surpassed all other treatments except 75% RDF + 25% FYM + *Azotobacter* (T₆) and 75% RDF + 25% Vermicompost (T₅), which were found to be statistically at par with heights of 60.27 cm and 58.53 cm, respectively. Conversely, the minimum plant height was recorded under the Control treatment (T₁) at 42.31 cm.

Regarding the leaf characteristics, the number of leaves per plant followed an identical trend to plant height, showing highly significant variations among the nutrient regimes. The maximum number of leaves (24.00) was achieved under

75% RDF + 25% Vermicompost + *Azotobacter* (T₈), showing a significant increase over the Control (T₁), which recorded the lowest number of leaves per plant (16.13 leaves). Similarly, the maximum leaf length and leaf width were also recorded under 75% RDF + 25% Vermicompost + *Azotobacter* (T₈) observing 52.03 cm leaf length and 27.01 cm leaf width, respectively. The lowest leaf length (35.09 cm) and leaf width (18.04 cm) were consistently observed in the Control treatment (T₁).

The physiological transition periods, measured by the days to 50% curd formation and days to 50% curd formation, showed variations among the treatment combinations; however, these parameters were found to be statistically non-significant at the 5% level of significance.

The significant acceleration and enhancement of vegetative growth attributes and phenological transitions in cauliflower under 75% RDF + 25% Vermicompost + *Azotobacter* (T₈) is a direct result of the favorable nutritional and physiological environment established by combining structured organic substrates with a microbial consortium. The maximum plant height, number of leaves per plant, leaf length and leaf width recorded under T₈ stem from the synergistic interaction between inorganic fertilizers, organic amendments, and microbial inoculants; the 75% RDF ensured an immediate supply of essential macronutrients, particularly nitrogen, to catalyze early cellular division, elongation, chlorophyll synthesis, and protein metabolism during the early vegetative phase (Sharma *et al.*, 2026)^[21], while the humified vermicompost base modified the physical architecture, aeration, and moisture retention of the rhizosphere to foster root proliferation, improve the soil's cation exchange capacity, and provide easily mineralizable, steady-release nutrients during peak vegetative demand (Rehman *et al.*, 2023)^[20]. This vegetative organogenesis and lateral laminar expansion were further enhanced by *Azotobacter* inoculation, which fixed atmospheric nitrogen and synthesized growth-regulating substances like auxins, gibberellins, and cytokines to stimulate apical and mesophyll cell division, increase nutrient-uptake efficiency, and promote a greater initiation of leaf primordia into a vigorous photosynthetic canopy with maximum light interception (Hafez *et al.*, 2016)^[8]. Conversely, the non-significant response of cauliflower to different nutrient modules regarding the days to 50% curd formation and the period between curd initiation and harvest suggests that these particular reproductive and maturation traits are more strongly governed by the genetic makeup of the cultivar and prevailing environmental conditions, such as temperature and photoperiod during the *Rabi* season, than by variations in nutrient application (Singh *et al.*, 2024)^[24]. Jaswal *et al.* (2025)^[10], Singh *et al.* (2024)^[24] and Bopche *et al.* (2024)^[6] also found similar results.

Effect of integrated nutrient management on yield attributes and yield of cauliflower

The data on the yield attributes and yield of cauliflower presented in the table 2 reveals a highly significant impact from the integrated nutrient management amendments. The physical dimensions of the cauliflower curd, measured via curd diameter and curd depth, exhibited notable variations across the different nutrient treatments. The maximum curd polar and equatorial diameter was recorded under 75% RDF + 25% Vermicompost + *Azotobacter* (T₈) at 16.42 cm and 18.51 cm respectively. On the other hand, the least curd

polar and equatorial diameter was observed in the Control treatment (T₁), recording 12 cm polar length and 13.02 cm equatorial length respectively.

The curd compactness followed a corresponding trend, showing a highly significant response to the synchronized nutrient treatments. The least curd compactness was successfully achieved under 75% RDF + 25% Vermicompost + *Azotobacter* (T₈) observing 14.74% compactness, while, the Control treatment (T₁) recorded the highest compactness at 27.82%.

Total yield was strongly influenced by the various nutrient management matrices. Reflecting the patterns observed in curd dimensions, treatment 75% RDF + 25% Vermicompost + *Azotobacter* (T₈) produced the maximum yield at 397.73 q/ha, performing statistically at par with treatment 75% RDF + 25% FYM + *Azotobacter* (T₆) and 75% RDF + 25% Vermicompost (T₅), which yielded 386.73 q/ha and 375.82 q/ha respectively. The lowest total yield was documented under the Control treatment (T₁) at 276.93 q/ha yield, showing that a complete lack of integrated nutrient management and balanced fertilization severely restricts overall crop productivity.

The significant acceleration and enhancement of yield attributes and total yield in cauliflower under 75% RDF + 25% Vermicompost + *Azotobacter* (T₈) is a direct result of the favorable nutritional and physiological environment established by combining structured organic substrates with a microbial consortium. The maximum curd polar length and equatorial diameter recorded under T₈ highlight the importance of a balanced nutrient supply in driving the vertical and radial expansion of the inflorescence, which can be attributed to the efficient translocation and partitioning of photo-assimilates from the vegetative source to the reproductive sink. The combination of 75% RDF and vermicompost ensures that the plant has access to an immediate and steady flux of macronutrients (particularly nitrogen and phosphorus) and vital micronutrients during the critical curd initiation and expansion phases, while simultaneously improving soil moisture retention and cation exchange capacity to maintain cell turgor and facilitate continuous lateral growth (Yaakob *et al.*, 2021; Oyege&Bhaskar, 2023)^[28, 16]. This structural development was further augmented by the inclusion of *Azotobacter*, which supplemented the nitrogen requirement through biological fixation and synthesized essential endogenous growth regulators—specifically gibberellins, auxins, and cytokines that promote longitudinal cell elongation, lateral bud development, and rapid cell division within the leaf mesophyll and floral curd branches (Hafez *et al.*, 2016)^[8]. Consequently, the lower curd compactness value observed in treatment T₈ is a direct consequence of this massive volumetric expansion, where the rapid proliferation and elongation of floral branches substantially increased the total curd volume, naturally lowering its density; conversely, the highest compactness value recorded in the Control (T₁) reflects severely restricted growth and limited volume where heads fail to expand vertically or radially due to nutrient deficiencies, resulting in a small, dense, and unmarketable structure (Thapliyal *et al.*, 2008)^[27]. Ultimately, the substantial increase in cauliflower yield under the integrated treatment T₈, represents the cumulative result of an elevated source capacity that sustained the crop from transplanting to harvest, an interpretation in close conformity with the findings reported by Jaswal *et al.* (2025)^[10], Bopche *et al.* (2024)^[6], Bajpai *et al.* (2023)^[5] and Ali *et al.* (2023)^[3].

Effect of integrated nutrient management on quality of cauliflower

The data on the quality parameters of cauliflower presented in the table 3 reveals that integrated nutrient management regimes exert a distinct influence on the physical structure and biochemical composition of the crop. The curd depth, a crucial physical parameter showed highly significant variations among the evaluated treatment matrices. The maximum curd depth was recorded under 75% RDF + 25% Vermicompost + *Azotobacter* (T₈) at 10.50 cm. Conversely, the minimum curd depth was recorded under the Control treatment (T₁) at 7.32 cm.

Another pivotal physical characteristic, curd solidity, followed an identical trend with highly significant responses across the synchronized nutrition applications. The highest curd solidity was successfully achieved under 75% RDF + 25% Vermicompost + *Azotobacter* (T₈), reaching a peak value of 47.50 g/cm. In contrast, the lowest curd solidity was documented under Control treatment (T₁), observing 45.11 g/cm solidity.

The biochemical sweetness and consumer preference index, evaluated through Total Soluble Solids (TSS), showed highly significant variations across the treatment combinations. The highest TSS concentration was successfully achieved under 75% RDF + 25% Vermicompost + *Azotobacter* (T₈), reaching a peak value of 9.98°Brix. In contrast, the lowest accumulation of soluble solids was documented under the Control treatment (T₁), observing 7.20°Brix TSS.

The antioxidant and nutritional profile of the cauliflower curds, quantified by the ascorbic acid (Vitamin C) content, was strongly enhanced by the integrated bio-organic frameworks. Consistent with the other quality metrics, 75% RDF + 25% Vermicompost + *Azotobacter* (T₈) produced the maximum ascorbic acid content at 78.86 mg/100g. Conversely, the Control treatment (T₁) resulted in a significant reduction in nutritional quality, recording the minimum ascorbic acid concentration of 57.98 mg/100g.

Similarly, the total sugar content was significantly maximized with the application of 75% RDF + 25% Vermicompost + *Azotobacter* (T₈), yielding a value of 2.50%. The lowest total sugar concentration was recorded under the Control treatment (T₁) at 1.69%. This demonstrates that unbalanced or deficient fertilization strategies lacking integrated macro- and micronutrient mobilization constraints can negatively impact the plant's overall biochemical biosynthesis and nutritional value.

The significant enhancement of quality parameters and biochemical profiles in cauliflower under 75% RDF + 25% Vermicompost + *Azotobacter* (T₈) is a direct result of the

favorable nutritional and physiological environment established by combining structured organic substrates with a microbial consortium. The substantial rise in curd depth under T₈ stems from the effective utilization of an optimized "source-sink" ratio, where the continuous influx of macronutrients from the 75% RDF, coupled with micronutrients and bioactive substances in vermicompost, promoted rapid cell division and floral primordia expansion; this vertical development was further aided by *Azotobacter*-derived gibberellins that induce the longitudinal elongation of the floral stalk and secondary branches (Zargar *et al.*, 2021) [29]. Similarly, the significantly higher curd solidity observed under T₈ reflects a compact, tightly arranged floral bud framework driven by a sustained nutrient flux during curd development, which maximized biomass accumulation and cell turgidity per unit length (Aguiar *et al.*, 2012) [2]. This superior physiological state heavily accelerated carbohydrate metabolism and enzyme activation, resulting in a significantly maximized Total Soluble Solids concentration and total sugar percentage due to an elevated rate of carbon fixation and efficient translocation of photo-assimilates from the wider foliar source to the economic sink (Shivran *et al.*, 2017; Meena *et al.*, 2017) [22, 12]. Furthermore, because ascorbic acid synthesis is a carbohydrate-dependent pathway, this enhanced photosynthetic efficiency provided an abundant pool of precursor hexose sugars for L-ascorbic acid biosynthesis, allowing treatment T₈ to produce the maximum vitamin C content (Smirnoff & Wheeler, 2024) [26]. This comprehensive interpretation strongly backed by the experimental findings of Jaswal *et al.* (2025) [10], Bopche *et al.* (2024) [6], Naorem *et al.* (2024) [14] and Bajpai *et al.* (2023) [5].

Conclusion

From the above results of the current experiment, 75% RDF + 25% Vermicompost + *Azotobacter* (T₈) had the best effect in terms of growth attributes, yield parameters, and quality traits of cauliflower. In terms of integrated nutrient management practices, treatment T₈ was found to be significantly effective over all other treatments on growth and yield attributes like plant height, number of leaves per plant, leaf length, leaf width, curd dimensions (polar and equatorial diameter) and total yield (397.73 q/ha), while successfully managing structural configurations like curd compactness and optimizing biochemical quality indices including curd depth, solidity, TSS, total sugars, and ascorbic acid content.

Given that this is based on a single season trial, additional evaluation trials are required to validate the findings.

Table 1: Effect of integrated nutrient management on growth of cauliflower

S. No.	Treatment	Treatment combination	Plant height (cm)	Days to 50% curd formation	Number of leaves per plant	Leaf length (cm)	Leaf width (cm)	Days taken for 50% curd initiation to harvest
1	T ₁	Control	42.31	73.65	16.13	35.09	18.04	21.72
2	T ₂	100% RDF (175: 75 :70)	55.33	69.64	20.95	46.18	23.87	19.90
3	T ₃	75% RDF + 25% FYM	53.41	70.66	20.54	44.50	22.97	20.11
4	T ₄	50% RDF + 50% FYM	49.09	72.74	18.70	40.77	20.98	20.54
5	T ₅	75% RDF + 25% Vermicompost	58.53	68.65	22.58	48.93	25.33	19.68
6	T ₆	75% RDF + 25% FYM + <i>Azotobacter</i>	60.27	67.67	23.30	50.47	26.16	19.46
7	T ₇	50% RDF + 50% FYM + <i>Azotobacter</i>	50.18	71.69	19.27	41.75	21.52	20.33
8	T ₈	75% RDF + 25% Vermicompost + <i>Azotobacter</i>	62.03	66.72	24.00	52.03	27.01	19.25
S.E. (m) (±)			2.14	2.26	0.82	1.82	0.84	0.68
C.D. @ 5%			6.51	NS	2.49	5.51	2.54	NS

Table 2: Effect of integrated nutrient management on yield and yield attributes of cauliflower

S. No.	Treatment	Treatment combination	Curd polar length (cm)	Curd equatorial length (cm)	Curd compactness (%)	Yield per hectare (q)
1	T ₁	Control	12.00	13.02	27.82	276.93
2	T ₂	100% RDF (175: 75 :70)	14.61	16.23	18.67	347.28
3	T ₃	75% RDF + 25% FYM	14.51	16.06	18.92	343.23
4	T ₄	50% RDF + 50% FYM	13.74	15.04	21.15	320.56
5	T ₅	75% RDF + 25% Vermicompost	15.68	17.54	16.18	375.82
6	T ₆	75% RDF + 25% FYM + Azotobacter	16.05	18.02	15.43	386.73
7	T ₇	50% RDF + 50% FYM + Azotobacter	13.75	15.12	21.10	322.54
8	T ₈	75% RDF + 25% Vermicompost + Azotobacter	16.42	18.51	14.74	397.73
S.E. (m) (±)			0.46	0.64	1.27	13.36
C.D. @ 5%			1.39	1.95	3.86	40.52

Table 3: Effect of integrated nutrient management on quality of cauliflower

S. No.	Treatment	Treatment combination	Curd depth (cm)	Curd solidity (g/cm)	TSS (°Brix)	Ascorbic acid (mg/100g)	Total sugars (%)
1	T ₁	Control	7.32	45.11	7.20	57.98	1.69
2	T ₂	100% RDF (175: 75 :70)	9.17	46.55	8.74	68.89	2.12
3	T ₃	75% RDF + 25% FYM	9.07	46.29	8.65	68.10	2.07
4	T ₄	50% RDF + 50% FYM	8.47	45.62	8.10	63.63	1.89
5	T ₅	75% RDF + 25% Vermicompost	9.93	46.96	9.45	74.54	2.32
6	T ₆	75% RDF + 25% FYM + Azotobacter	10.21	47.22	9.72	76.69	2.41
7	T ₇	50% RDF + 50% FYM + Azotobacter	8.52	45.87	8.14	64.01	1.93
8	T ₈	75% RDF + 25% Vermicompost + Azotobacter	10.50	47.50	9.98	78.86	2.50
S.E. (m) (±)			0.34	0.43	0.21	1.59	0.05
C.D. @ 5%			1.04	1.29	0.63	4.81	0.16

References

- Aasfar A, Bargaz A, Yaakoubi K, Hilali A, Bennis I, Zeroual Y, *et al.* Nitrogen fixing *Azotobacter* species as potential soil biological enhancers for crop nutrition and yield stability. *Front Microbiol.* 2021;12:628379.
- Aguiar N, Olivares FL, Novotny F, Dobbss LB. Bioactivity of humic acids isolated from vermicomposts at different maturation stages. *Plant Soil.* 2012;362:1-2.
- Ali S, Sapkal DR, Pandey S, Kumar C, Sanyal S. Study on the effect of biofertilizers on the growth and yield of cauliflower (*Brassica oleracea* L. var. botrytis). *Int J Novel Res Dev.* 2023;8(5):e553.
- Anonymous. Area and production of horticulture crops, 2025-26 (first advance estimates). Department of Agriculture & Farmers' Empowerment. 2025.
- Bajpai R, Singh SK, Bhati D, Tyagi DB, Nehal N. Improvement in plant growth and yield of cauliflower after application of biofertilizers and inorganic nutrient sources. *Ann Biol.* 2023;39(1):82-86.
- Bopche V, Agrawal S. Impact of organic manures on the growth and yield of cauliflower. In: *BIO Web of Conferences.* Vol. 110. EDP Sciences; 2024. p. 01003.
- Fusari CM, Nazareno MA, Locatelli DA, Fontana A, Beretta V, Camargo AB. Phytochemical profile and functionality of Brassicaceae vegetables. *Food Biosci.* 2020;36:100606.
- Hafez SK, El-Beik AK, El-Tantawy AM, ElKasas AI. Effect of organic and bio-fertilizer sources on summer squash under El-Arish conditions. *Sinai J Appl Sci.* 2016;5(2):155-172.
- Jangir R, Thanki JD, Patil KB, Saini LK. Residual and direct effect of integrated nutrient management on growth, yield, monetary efficiency, nutrient uptake of cowpea and soil properties under grain amaranth-cowpea cropping sequence in Inceptisols of Western India. *J Plant Nutr.* 2021:1-21.
- Jaswal S, Kumar A, Sepehya S, Kochithara EJ, Jaswal K. Synergistic effect of nitrogen substitution through vermicompost on productivity and quality of cauliflower in low hills of Himachal Pradesh, India. *Int J Plant Soil Sci.* 2025;37(9):435-445.
- Kaur P, Mal D. Effect of foliar spray of NAA and GA3 on the growth, curd formation and yield of cauliflower (*Brassica oleracea* L. var. botrytis). *J Pharmacogn Phytochem.* 2018;7(3):2805-2807.
- Meena JS, Meena ML, Meena NK, Meena RK. Impact of integrated nutrient management on broccoli yield. *J Plant Dev Sci.* 2017;9(4):371-374.
- Mpumi N, Machunda RS, Mtei KM, Ndakidemi PA. Selected insect pests of economic importance to *Brassica oleracea*, their control strategies and the potential threat to environmental pollution in Africa. *Sustainability.* 2020;12(9):3824.
- Naorem J, Sarkar A, Bihari C, Adhikary NK, Kanaujia SP, Maiti CS, *et al.* Effect of different sources of concentrated organic inputs and bio-fertilizers on growth, yield and quality of broccoli cv. Calabrese. *Environ Ecol.* 2024;42(3A):1194-1200.
- Ojetayo AE, Olaniyi JO, Akanbi WB, Olabiyi TI. Effect of fertilizer types on nutritional quality of two cabbage varieties before and after storage. *J Appl Biosci.* 2011;48(5):3322-3333.
- Oyege I, Bhaskar MSB. Effects of vermicompost on soil and plant health and promoting sustainable agriculture. *Soil Syst.* 2023;7(4):3390.
- Panse VG, Sukhatme PV. *Statistical methods for agricultural workers.* New Delhi: ICAR; 1985.
- Prasad B, Sinha SK. Long-term effects of fertilizers and organic manures on crop yields, nutrient balance and

- soil properties in rice-wheat cropping system in Bihar. In: Long-term soil fertility experiments in rice-wheat cropping systems. Rice-Wheat Consortium Paper Series. 2000;6:105-119.
19. Raiola A, Errico A, Petruk G, Monti DM, Barone A, Rigano MM. Bioactive compounds in *Brassicaceae* vegetables with a role in the prevention of chronic diseases. *Molecules*. 2018;23(1):15.
 20. Rehman SU, De Castro F, Aprile A, Benedetti M. Vermicompost: enhancing plant growth and combating abiotic and biotic stress. *Agronomy*. 2023;13(4):1134.
 21. Sharma V, Sharma OP, Joshi D, Shekhawat AS. Influence of fertility levels, biofertilizers and stress extenuating chemicals on growth and yield of mungbean (*Vigna radiata* L.). *Int J Sci Res Arch*. 2026;18(2):542-552.
 22. Shivran BC, Meena ML, Ola AL, Choudhary GR, Meena JK, Atal MK. Impact of biofertilizers and zinc on biochemical parameters of sprouting broccoli (*Brassica oleracea* var. *italica*). *J Pharmacogn Phytochem*. 2017;6:2065-2067.
 23. Singh A, Maji S, Kumar S. Effect of biofertilizers on yield and biomolecules of anti-cancerous vegetable broccoli. *Int J Bio-resour Stress Manag*. 2014;5(2):262-268.
 24. Singh SK, Singh DK, Nirankar, Singh U. Effect of integrated nutrient management on growth, yield and quality parameters of cauliflower. *Veg Sci*. 2024;50(2):338-342.
 25. Singh S, Bhatia R, Kumar R. Characterization and genetic analysis of OguCMS and doubled haploid based large genetic arsenal of Indian cauliflowers. *Genet Resour Crop Evol*. 2021;68(4):1603-1623.
 26. Smirnoff N, Wheeler GL. The ascorbate biosynthesis pathway in plants is known, but there is a way to go with understanding control and functions. *J Exp Bot*. 2024;75(9):2604-2630.
 27. Thapliyal A, Uniyal SP, Bhatt L, Bhusan B. Effect of organic nitrogen sources along with urea and bioagents on growth, yield and quality of cabbage (*Brassica oleracea* var. *capitata*). *Prog Agric*. 2008;8(2):173-176.
 28. Yaakob MA, Mohamed RMSR, Al-Gheethi A, Gokare RA, Ambati RR. Influence of nitrogen and phosphorus on microalgal growth, biomass, lipid and fatty acid production: an overview. *Cells*. 2021;10(2):393.
 29. Zargar J, Kumar M, Kumar S, Chopra S, Kumar S, Bhushan A, *et al*. Integrated nutrient management studies in cabbage (*Brassica oleracea*) under subtropical plains of Jammu. *Indian J Agric Sci*. 2021;92(1):59-62.