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Research Article

The Effect Of Organic Fertilization and Method of Irrigation on Yield and Quality of Cauliflower in Field Organic Cultivation

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Abstract

In a three-year experiment, the effects of organic fertilization and irrigation on the yield, curd diameter and selected physiological indicators of cauliflower plants were investigated. The experiment compared three irrigation treatments: micro-sprinkler irrigation, drip irrigation and control (no irrigation). The fertilization treatments included: compost applied at a rate of 30 t/ha, Fertilan fertilizer (with an N-P-K ratio of 5.5-0.2-2.0), derived from alfalfa and sheep wool, applied at two nitrogen levels (180 and 240 kg N/ha), and Control (no fertilization). The three-year study confirmed the significant role of organic fertilization, particularly with Fertilan, in improving vegetative biomass and curd yield in cauliflower. Irrigation enhanced yields only in the first year, indicating that its impact may depend on weather conditions and soil moisture availability. Organic fertilizers not only improved yield but also influenced physiological traits such as chlorophyll content and nitrogen status, supporting their continued use in sustainable cauliflower production systems.

Keywords: Cauliflower Fertilization; Organic Fertilization; Irrigation; Physiological Traits; Yield

Introduction

Cauliflower (*Brassica oleracea var. botrytis*) is a horticultural crop characterized by high nutritional demands and substantial water requirements, primarily due to its rapid growth rate and considerable biomass accumulation within a relatively short vegetative period [1]. Soil moisture during the growing season plays a critical role in cauliflower cultivation. The application of hydrophilic soil conditioners has been shown to enhance soil moisture retention, thereby improving biomass production and curd quality [2]. Seasonal water requirements for cauliflower range from 380 to 500 mm, with irrigation intervals typically spanning 5 to 10 days [3]. Among irrigation methods, drip irrigation has consistently yielded the highest productivity [4]. Plants irrigated at a soil water potential of -20 kPa produced curds of acceptable market quality [1], whereas drought stress inhibited curd formation, rendering crops unmarketable [5].

Irrigation and fertilization are major determinants of both yield and curd quality in cauliflower. Under irrigated conditions, the plant's demand for nutrients—particularly nitrogen—increases due to enhanced biomass development. A statistically significant interaction has been reported between irrigation levels and nitrogen fertilization [6]. Optimal yields were achieved under full irrigation combined with nitrogen application at a rate of 225 kg N ha^{-1} [4].

In conventional systems, fertilization strategies are based on crop nutritional requirements, projected yields, soil type, existing nutrient levels, and crop rotation practices. In contrast, organic agriculture prohibits the use of synthetic mineral fertilizers, making organic amendments the primary sources of nutrients and soil organic matter [7]. Plant-based organic fertilizers are nutrient-rich and contribute not only to improved yield and product quality but also to environmental sustainability [8,9]. Their use has been shown to positively influence growth parameters and quality traits in cauliflower cultivars [10]. Common organic fertilizers in organic systems include green manures, animal manure, and compost [8,11]. Green manures are a widely accessible fertilization strategy, suitable for implementation across diverse farm types. According to Lynge., *et al*. [12], annual green manure crops can contribute between 110 and 320 kg N ha^{-1}. Leguminous species are particularly advantageous due to their capacity for atmospheric nitrogen fixation [13]. Intercropping cauliflower with clover has demonstrated positive agronomic effects [14]. Similarly, the use of red clover mulch in sweet pepper cultivation increased nitrogen content in both soil and plant tissue, resulting in higher yields [15]. Innovative fertilizers derived from clover and alfalfa were found to produce onion yields comparable to those obtained using conventional split applications of mineral nitrogen [16]. Sørensen and Thorup-Kristensen [17] also indicated that other fast-growing, high-biomass species could serve effectively as green manure. Crucifer-derived green manures, rich in phosphorus (P) and sulfur (S), improved nutrient uptake and enhanced potted cauliflower yields. However, high carbon-to-nitrogen (C:N) ratios in green manure were associated with yield suppression due to delayed nutrient mineralization.

In organic cropping systems, organic fertilizers are applied both as a base fertilization strategy (pre-sowing) and as a supplemental nutrient source during the growing season, particularly to meet nitrogen demands. Granular organic fertilizers, derived from legumes and fortified with additional organic compounds, represent a promising alternative for nutrient management in organic vegetable production. Granulation reduces ammonia volatilization, lowers application costs, and facilitates mid-season application [18]. Böhme., *et al*. [19] reported successful use of sheep wool pellets as an organic fertilizer for vegetables and ornamental crops under organic management. Waste sheep wool is especially rich in nitrogen and sulfur, making it a valuable organic input [20] Karaca., *et al*. [21] observed that increasing rates of sheep wool fertilizer improved soil aeration and moisture retention, attributed to the fiber's swelling during decomposition.

Research on tomato and spinach demonstrated that higher application rates of organic fertilizers led to increased yields, with no significant differences observed between commercial products and wool-based granular fertilizers applied at equivalent nitrogen rates [22]. In pot experiments with tomato and pepper, the addition of 10 g wool dm^3 of substrate increased yields by 33% [23]. Broda., *et al*. [24] concluded that waste wool constitutes an environmentally sustainable, nitrogen-rich fertilizer that supports sustainable plant production.

The effectiveness of organic fertilization is closely linked to soil moisture conditions, and thus to precipitation patterns during the growing season. Under low-moisture conditions, organic matter decomposition slows, reducing the release and availability of mineralized nutrients. Abd El-Kader [25] demonstrated that nutrient uptake is significantly influenced by both water availability and organic nutrient sources. Higher irrigation regimes were associated with increased uptake of nitrogen (N), phosphorus (P), and potassium (K), alongside improvements in growth and yield parameters of okra compared to plants grown under limited irrigation. Findings by Shams., *et al*. [26] indicated that compost application mitigated the negative effects of water stress on cauliflower production.

The aim of this study was to evaluate the impact of organic fertilization and various irrigation methods on the yield and quality of cauliflower under organic farming conditions.

Materials and Methods

The field experiment was conducted over three consecutive growing seasons (2021, 2022, and 2023) at the National Institute of Horticultural Research in Skierniewice, located in central Poland. The trial was arranged in a two-factor factorial design with four replications. In each year, cauliflower (Brassica oleracea var. botrytis) cultivar 'Pionier' was grown from transplants and established on sandy loam soil characterized by the following composition: 68% sand (0.1–1 mm), 19% silt (0.1–0.2 mm), and 13% clay (<0.02 mm). The soil had a pH of 6.5 and an organic matter content of 1.16%. Transplanting dates varied by year: 14 July in 2021, 5 May in 2022, and 30 June in 2023.

The experiment compared three irrigation treatments:

- Micro-sprinkler irrigation,
- Drip irrigation,
- Control (no irrigation).

The fertilization treatments included:

- Compost at a rate of 30 t/ha,
- Fertilan fertilizer (with an N-P-K ratio of 5.5-0.2-2.0), derived from alfalfa and sheep wool, applied at two nitrogen levels (180 and 240 kg N/ha),
- Control (no fertilizer).

Both compost and Fertilan were incorporated into the soil as pre-plant fertilization. Meteorological data, including temperature and precipitation, were recorded throughout the growing seasons using an on-site automated weather station (see Figure 1). Irrigation scheduling was based on soil moisture levels, monitored using tensiometers. Irrigation was initiated when soil water potential dropped to –30 kPa. The amount of water applied per event was 2 liters per plant for drip irrigation and 20 mm per application for the micro-sprinkler system.

The determination of the chlorophyll, flavonol, and NBI indices was performed using the Dualex Scientific+ device. This device utilizes UV and red radiation (375 nm and 650 nm) to induce chlorophyll fluorescence, along with photodiode detectors to indirectly estimate *in vivo* absorption by the leaf epidermis [15]. Radiation at a wavelength of 375 nm (UV) excites chlorophyll, resulting in fluorescence. However, the intensity of this radiation decreases as it is absorbed by the leaf epidermis. In contrast, red light, which also excites chlorophyll fluorescence, is not absorbed by flavonols and therefore its signal is independent of their concentration. The device then compares the intensity of chlorophyll fluorescence that is attenuated by flavonols (ChlF_UV) with that which is not (ChlF_R). The flavonol content is calculated based on the formula: FLAV=log(ChlF_R/ChlF_UV). The chlorophyll index (Chl) is assessed based on the difference in light transmission through the leaf between 710 and 850 nm. The NBI index is calculated as the ratio of Chl/Flav.

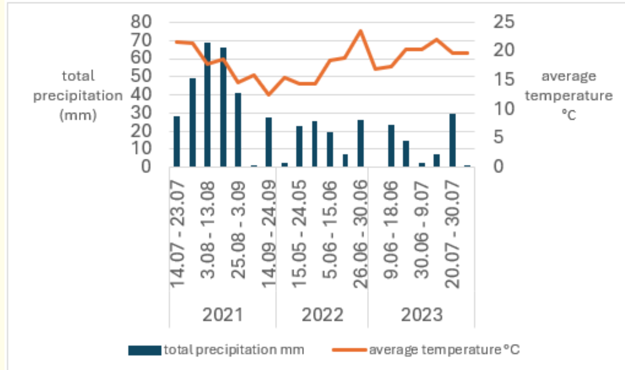

Figure 1: Total precipitation and average temperature (2021 – 2023).

Results and Discussion

Effect of organic fertilization and irrigation on biomass production and curd yield

The beneficial effects of organic fertilizers on plant growth and development are primarily attributed to the improvement of the physical, chemical, and biological properties of soil. These improvements promote better root system development, enhanced nutrient uptake, and more efficient nutrient translocation during vegetative growth [27]. In organic production systems, organic fertilization is a key source of humus and nutrients [17].

Our study demonstrated a significant effect of both organic fertilization and irrigation method on cauliflower biomass production, although this effect varied across the three years of the experiment. The highest biomass yields were recorded for treatments using Fertilan at a dose equivalent to 240 kg N ha^{-1}. However, in 2023, differences between Fertilan (180 and 240 kg N ha^{-1}) and compost (30 t ha^{-1}) were not statistically significant (Table 1). The lowest biomass was consistently observed in the unfertilized control treatment.

Drip and sprinkler irrigation significantly increased biomass yield only in 2021. In the subsequent two years, irrigation had no significant effect on biomass accumulation, and no interaction between fertilization and irrigation method was observed in any year.

The yield of cauliflower curds was significantly influenced by the type and dose of organic fertilizer (Table 2). In all three years, the highest yields were obtained with Fertilan at a dose of 240 kg N ha^{-1}. Compost application at 30 t ha^{-1} significantly increased curd yield in two years, and in the third year, it was statistically comparable to Fertilan 180 kg N ha^{-1}.

Unfertilized controls consistently produced the lowest curd yields. Similar to biomass yield, irrigation (both sprinkler and drip) significantly improved curd yield only in the first year. No significant interaction between fertilization and irrigation methods was noted.

Method of irrigation	Fertilization treatment	Year of cultivation		
		2021	2022	2023
Control (No irrigation)	Control without fertilization	7.56 ±1.16 d	13.50 ± 2.17 bc	29.65 ± 8.81 ab
	Fertilan 180	12.72 ±2.97 cd	18.83 ± 4.18 abc	29.38 ± 6.72 ab
	Fertilan 240	17.93 ±5.74 abc	19.44 ± 6.98 abc	34.04 ± 6.48 ab
	Compost 30t/ha	10.06 ±2.12 d	16.82 ± 4.74 abc	32.36 ± 7.53 ab
Sprinkler irrigation	Control without fertilization	9.27 ±1.61 d	13.05 ± 3.92 bc	18.72 ± 11.60 b
	Fertilan 180	19.86 ± 1.44 ab	22.77 ± 3.84 ab	28.33 ± 7.62 ab
	Fertilan 240	23.21 ± 3.22 ab	26.24 ± 6.01 a	42.13 ± 11.21 a
	Compost 30t/ha	16.74 ± 0.64 bc	21.71 ± 5.30 abc	31.65 ± 11.99 ab
Drip irrigation	Control without fertilization	8.61 ± 2.22 d	11.21 ± 3.36 c	17.59 ± 4.23 b
	Fertilan 180	20.93 ± 2.66 ab	23.43 ± 4.54 ab	38.87 ± 9.39 ab
	Fertilan 240	23.98 ±1.63 a	24.18 ± 4.00 ab	29.12 ± 14.40 ab
	Compost 30t/ha	13.16 ± 3.04 cd	16.13 ± 3.50 abc	17.24 ± 3.14 b
Mean value for method of irrigation	Control	12.07 ± 5.03 b	17.15 ± 4.94 ns	31.36 ± 6.95 ns
	Sprinkler irrigation	17.27 ± 5.60 a	18.74 ± 6.54 ns	30.21 ± 12.92 ns
	Drip irrigation	16.67 ± 6.67 a	20.94 ± 6.63 ns	25.71 ± 12.28 ns
Mean value for fertiliza-tion treatment	Control without fertilization	8.48 ± 1.72 d	12.58 ± 3.10 c	21.99 ± 9.74 b
	Fertilan 180	17.83 ± 4.40 b	21.67 ± 4.35 ab	32.20 ± 8.76 a
	Fertilan 240	21.71 ± 4.52 a	23.29 ± 6.03 a	35.10 ± 11.56 a
	Compost 30t/ha	13.32 ± 3.46 c	18.22 ± 4.88 b	27.08 ± 10.50 ab

Table 1: Effect of irrigation and organic fertilization on cauliflower biomass production (t ha^{-1}).

Method of irrigation	Fertilization treatment	Year of cultivation		
		2021	2022	2023
Control (No irrigation)	Control without fertilization	4.32 ± 2.01 f	4.97 ± 1.16 b	11.74 ± 6.48 ab
	Fertilan 180	8.56 ± 4.07 def	8.30 ± 2.23 ab	11.51 ± 4.45 ab
	Fertilan 240	13.85 ± 6.53 bcde	9.09 ± 4.51 ab	14.38 ± 2.45 ab
	Compost 30t/ha	8.35 ± 1.91 def	7.39 ± 2.98 ab	14.04 ± ab
Sprinkler irrigation	Control without fertilization	6.57 ± 1.32 ef	5.25 ± 2.44 b	7.52 ± 7.14 ab
	Fertilan 180	17.69 ± 1.67 abc	11.06 ± 3.32 ab	11.73 ± 4.82 ab
	Fertilan 240	21.13 ± 3.01 ab	12.67 ± 3.99 a	19.69 ± 5.98 a
	Compost 30t/ha	14.77 ± 0.49 abcd	7.49 ± 2.49 ab	15.52 ± 6.74 ab

Drip irrigation	Control without fertilization	6.27 ± 3.44 f	4.80 ± 2.21 b	5.99 ± 3.21 b
	Fertilan 180	19.03 ± 2.30 ab	11.96 ± 3.05 ab	17.81 ± 5.07 ab
	Fertilan 240	21.64 ± 1.17 a	11.88 ± 3.28 ab	11.83 ± 6.89 ab
	Compost 30t/ha	11.16 ± 3.26 cdef	6.74 ± 1.89 ab	5.22 ± 1.84 b
Mean value for method of irrigation	Control	8.77 ± 5.06 b	7.44 ± 3.11 ns	12.92 ± 4.31 ns
	Sprinkler irrigation	15.04 ± 5.80 a	8.84 ± 4.04 ns	13.61 ± 7.27 ns
	Drip irrigation	14.52 ± 6.78 a	9.12 ± 4.11 ns	10.21 ± 6.70 ns
Mean value for fertilization treatment	Control without fertilization	5.72 ± 2.43 d	5.00 ± 1.83 b	8.42 ± 5.89 b
	Fertilan 180	15.09 ± 5.50 b	10.44 ± 3.09 a	13.68 ± 5.29 ab
	Fertilan 240	18.87 ± 5.31 a	11.22 ± 3.92 a	15.30 ± 6.00 a
	Compost 30t/ha	11.42 ± 3.39 c	7.21 ± 2.28 b	11.59 ± 6.36 ab

Table 2: Effect of irrigation and organic fertilization on cauliflower curd yield (t ha^{-1}).

Averaged over the three years, Fertilan application at 180–240 kg N ha^{-1} increased curd yield more than twofold compared to the control, while compost improved yield by 57%. These results confirm findings by other authors indicating the positive influence of organic fertilizers—such as manures, composts, and green manures—on soil structure, nutrient content, aeration, and water retention, which ultimately enhance crop productivity [7,10,17,19,21,24].

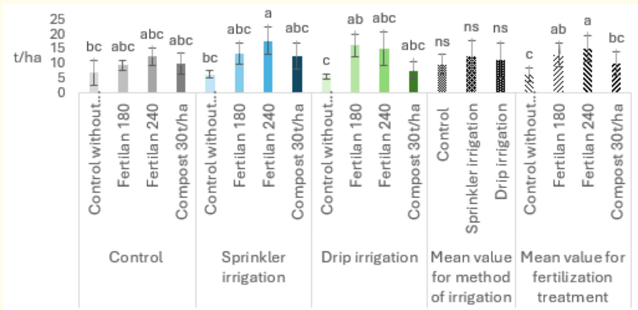

Figure 2: Average curd production of cauliflower (2021–2023).

Curd diameter

The curd diameter was correlated with the cauliflower yield. The smallest curd diameter was recorded in 2022. Both drip and sprinkler irrigation significantly increased the curd diameter compared to the control combination, although the effect of irrigation on curd diameter varied across the study years. The application of Fertilan fertilizer had a beneficial effect on curd diameter and significantly increased the size of the curds compared to both the control and compost fertilization. On average over the three years of the study, the best combination was drip irrigation with a Fertilan dose equivalent to 180 kg N/ha. The results of this experiment correspond to the information of Okasha., *et al.* [4], who reported that drip irrigation produced highest cauliflower curd yield.

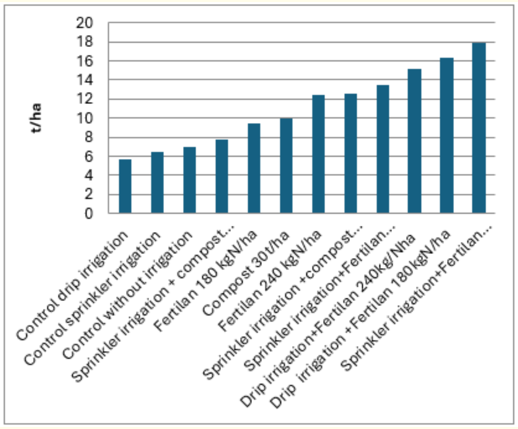

Figure 3: Marketable curd production depending on organic fertilization and irrigation method (mean 2021–2023).

Method of irrigation	Fertilization treatment	Curd diameter		
		2021	2022	2023
Control (No irrigation)	Control without fertilization	14.05 ± 2.60 b	12.65 ± 1.29 c	14.88 ± 0.20 de
	Fertilan 180	17.31 ± 4.23 ab	14.25 ± 0.91 abc	15.87 ± 0.23 c
	Fertilan 240	18.86 ± 4.20 ab	15.21 ± 1.38 abc	14.76 ± 0.27 e
	Compost 30t/ha	15.92 ± 3.03 ab	13.55 ± 0.71 bc	13.81 ± 0.21 f

Sprinkler irrigation	Control without fertilization	15.92 ± 1.57 ab	13.54 ± 1.06 bc	11.43 ± 0.21 g
	Fertilan 180	18.96 ± 1.04 ab	15.54 ± 1.64 ab	15.09 ± 0.28 de
	Fertilan 240	20.78 ± 1.78 a	16.96 ± 0.75 a	17.50 ± 0.32 a
	Compost 30t/ha	17.84 ± 0.82 ab	14.89 ± 0.52 abc	16.60 ± 0.29 b
Drip irrigation	Control without fertilization	15.33 ± 1.34 ab	14.74 ± 1.02 abc	13.22 ± 0.23 f
	Fertilan 180	19.13 ± 1.34 ab	16.29 ± 1.05 ab	17.77 ± 0.34 a
	Fertilan 240	19.91 ± 0.96 a	16.13 ± 1.79 ab	15.46 ± 0.27 cd
	Compost 30t/ha	16.84 ± 1.47 ab	14.59 ± 1.27 abc	13.33 ± 0.24 f

Table 3: Effect of organic fertilization and irrigation method on curd diameter.

Leaf chlorophyll index

The chlorophyll index (Chl), an indirect indicator of leaf nitrogen status and photosynthetic capacity, was positively affected by fertilization (Table 4). In all years, Fertilan (especially 240 kg N ha^{-1}) significantly increased the chlorophyll index compared to the control. The differences were more evident in 2023.

Sprinkler and drip irrigation had a less consistent effect on Chl values. In 2023, control treatments under sprinkler irrigation showed significantly lower Chl levels than fertilized treatments, suggesting that nutrient availability had a stronger influence on chlorophyll content than water supply.

Method of irrigation	Fertilization treatment	Chl		
		2021	2022	2023
Control (No irrigation)	Control without fertilization	28.93 ± 2.39 ab	36.45 ± 3.39 ab	49.28 ± 4.08 ab
	Fertilan 180	30.33 ± 0.62 ab	39.83 ± 2.16 ab	52.27 ± 0.33 a
	Fertilan 240	30.74 ± 2.46 ab	41.16 ± 3.12 a	52.05 ± 1.56 a
	Compost 30t/ha	30.41 ± 2.38 ab	36.54 ± 1.93 ab	47.83 ± 3.76 abc
Sprinkler irrigation	Control without fertilization	27.62 ± 1.43 ab	35.66 ± 1.81 ab	37.79 ± 3.41 c
	Fertilan 180	30.73 ± 1.64 ab	39.56 ± 2.34 ab	43.61 ± 6.40 abc
	Fertilan 240	30.70 ± 3.08 ab	38.73 ± 2.77 ab	44.38 ± 4.54 abc
	Compost 30t/ha	27.41 ± 2.11 ab	35.68 ± 2.85 ab	37.90 ± 6.84 c
Drip irrigation	Control without fertilization	27.07 ± 2.05 b	36.25 ± 5.11 ab	41.16 ± 3.75 bc
	Fertilan 180	30.84 ± 0.84 ab	38.12 ± 1.68 ab	42.80 ± 5.42 abc
	Fertilan 240	32.31 ± 1.35 a	39.83 ± 1.91 ab	42.71 ± 3.09abc
	Compost 30t/ha	29.25 ± 2.11 ab	33.22 ± 3.09 b	37.85 ± 2.03 c

Table 4: Effect of organic fertilization and irrigation method on leaf chlorophyll index of cauliflower.

Leaf flavonol index

The leaf flavonol index (Flav), reflecting stress responses and phenolic compound accumulation, was less sensitive to fertilization and irrigation (Table 5). No statistically significant differences were found in most treatments across the years. Slightly lower Flav values in Fertilan-treated plants could be attributed to improved plant health and lower oxidative stress.

Method of irrigation	Fertilization treatment	Flav		
		2021	2022	2023
Control (No irrigation)	Control without fertilization	2.14 ± 0.05 ab	1.95 ± 0.15 ns	1.81 ± 0.20 ns
	Fertilan 180	2.07 ± 0.12 ab	1.83 ± 0.03 ns	1.80 ± 0.13 ns
	Fertilan 240	2.05 ± 0.08 ab	1.83 ± 0.03 ns	1.70 ± 0.09 ns
	Compost 30t/ha	2.10 ± 0.06 ab	1.96 ± 0.12 ns	1.76 ± 0.09 ns
Sprinkler irrigation	Control without fertilization	2.17 ± 0.01 ab	1.94 ± 0.11 ns	1.92 ± 0.17 ns
	Fertilan 180	2.08 ± 0.02 ab	1.82 ± 0.20 ns	1.83 ± 0.11 ns
	Fertilan 240	2.09 ± 0.06 ab	1.86 ± 0.10 ns	1.75 ± 0.28 ns
	Compost 30t/ha	2.16 ± 0.03 ab	1.95 ± 0.03 ns	1.98 ± 0.27 ns
Drip irrigation	Control without fertilization	2.18 ± 0.03 a	1.88 ± 0.12 ns	1.90 ± 0.12 ns
	Fertilan 180	2.09 ± 0.04 ab	1.84 ± 0.04 ns	1.86 ± 0.17 ns
	Fertilan 240	2.03 ± 0.02 b	1.81 ± 0.04 ns	1.91 ± 0.07 ns
	Compost 30t/ha	2.12 ± 0.07 ab	1.91 ± 0.03 ns	2.02 ± 0.07 ns

Table 5: Effect of organic fertilization and irrigation on flavonol index of cauliflower leaves.

Nitrogen balance index (NBI)

NBI, representing the ratio of chlorophyll to flavonol indices, was higher in fertilized treatments, particularly with Fertilan at 240 kg N ha^{-1} (Table 6). In 2023, these differences were more pronounced. Compost treatments showed moderate increases in NBI, while control treatments remained significantly lower.

Method of irrigation	Fertilization treatment	NBI		
		2021	2022	2023
Control (No irrigation)	Control without fertilization	13.70 ± 1.49 ab	19.16 ± 2.89 ns	28.08 ± 5.11 abc
	Fertilan 180	14.77 ± 1.24 ab	22.07 ± 1.64 ns	29.59 ± 2.22 ab
	Fertilan 240	15.17 ± 1.84 ab	22.74 ± 1.74 ns	31.14 ± 1.26 a
	Compost 30t/ha	14.58 ±1.53 ab	18.99 ± 1.63 ns	27.83 ± 2.72 abc
Sprinkler irrigation	Control without fertilization	12.76 ± 0.65 b	18.62 ± 1.17 ns	20.34 ± 3.50 bc
	Fertilan 180	14.75 ± 0.83 ab	22.40 ± 3.33 ns	24.79 ± 4.96 abc
	Fertilan 240	14.82 ±1.80 ab	21.14 ± 1.73 ns	27.06 ± 6.53 abc
	Compost 30t/ha	12.72 ± 0.81 b	18.70 ± 1.50 ns	20.52 ± 6.93 bc
Drip irrigation	Control without fertilization	12.44 ± 1.03 b	19.81 ± 3.85 ns	22.15 ± 3.29 abc
	Fertilan 180	14.83 ± 0.26 ab	21.06 ± 1.16 ns	23.56 ± 4.98 abc
	Fertilan 240	16.12 ± 0.60 a	22.28 ± 1.04 ns	22.83 ± 2.31 abc
	Compost 30t/ha	13.83 ± 1.23 ab	17.61 ± 1.82 ns	19.13 ± 1.47 c

Table 6: Effect of organic fertilization and irrigation method on nitrogen balance index (NBI) of cauliflower.

Conclusion

Overall, the three-year study confirmed the significant role of organic fertilization, particularly with Fertilan, in improving biomass and curd yield in cauliflower. Irrigation enhanced yields only in the first year, indicating that its impact may depend on weather conditions and soil moisture availability. Organic fertilizers not only improved yield but also influenced physiological traits such as chlorophyll content and nitrogen status, supporting their continued use in sustainable cauliflower production systems. From a practical perspective, the use of Fertilan fertilizer at a rate of 180 kg N ha^{-1} combined with drip irrigation can be recommended as an efficient and sustainable management strategy for organic cauliflower production under similar soil and climatic conditions.

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