

Effect of Bio Fertilization on Growth and yield of two Romanesco cauliflower varieties

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The Abstract

This study was conducted under the conservative conditions of Babil during the agricultural season 2023-2024 in a private field in the Musayyib area (45 km north of the center of Hilla) located at longitude E44.5 and latitude N32.7. The aim was to study the effect of different biofertilizer treatments on the growth and yield of two varieties of Romanesco cauliflower plants (*Brassica oleracea* var. *Botrytis Romanesco*). The experiment applied a randomized complete block design (RCBD) with three replications. The first factor was biofertilizer application (comparison, Biohealth fertilizer, Novatec21 fertilizer), and the second factor was two varieties of Romanesco cauliflower (8026 and Sow).

The research results showed significant differences between the varieties in most vegetative growth and quantitative and qualitative yield indicators. Variety 8606 showed significant superiority in all vegetative traits and yield, with a plant height of 96.20 cm, 24.306 leaves per plant, 21.68% leaf dry matter content, leaf area of 7344 cm² per plant, total chlorophyll content of 64.7 spad, flower head diameter of 21.378 cm, flower head weight of 928.3 g per plant, and a total yield of 37132 tons per hectare, while the Sow variety showed significant superiority in the percentage of Calcium in the flower heads 0.2246%, sulfur content 0.676%, and magnesium content 0.208%.

The results indicated significant differences in the majority of vegetative growth and yield quality indicators for Bio fertilizers. The treatment of adding Novatec21 fertilizer excelled in plant height by 91.90, dry matter content by 21.68%, total chlorophyll content in leaves by 63.7%, leaf area by 7781 cm² per plant, disc diameter of 23.179 cm, disc weight of 975.7 grams per plant, and total yield of 39013 tons per hectare. The Biohealth fertilizer treatment excelled in the number of leaves by 24.403 per plant.

The results showed significant interaction between the variety and Bio fertilizer in most vegetative growth indicators and yield quality indicators for Romanesco cauliflower. The interaction of variety 8606 × Novatec21 significantly excelled in floral disc weight by 978.4 grams per plant and total yield of 39138 tons per hectare.

Keywords. Cauliflower Romanesco , Surface layer, Bio Fertilization.

1-Introduction

Brassica oleracea var. *Botrytis Romanesco*, commonly referred to as Romanesco cauliflower, is a member of the Brassicaceae family. It is among those vegetable varieties that prefers moderate temperatures but is susceptible to cold. It is regarded as one of the sixteenth-century exotic vegetables that Italy was acquainted with. The peculiarity arises from the fact that this variety of vegetable amalgamates cauliflower. Broccoli, alternatively referred to as Romanesco cauliflower, Romanesco broccoli, or Romanesco cabbage, has gained notoriety due to its conspicuous appearance, pale green hue, and spiral arrangement of pointed-headed conical blooms. It resembles broccoli and cauliflower in that it has a moderate flavor, but its texture is slightly firmer [1]. Each 100 g of the edible portion contains 94 g of water, carbohydrates 4.99 g, proteins 2.42 g, fats 0.25 g, calcium 20 mg, phosphorus 48 mg, potassium 326 mg, magnesium 17 mg, iron 0.9 mg, sodium 19 mg, and vitamin A 589 mg [2]. There are numerous varieties of microorganisms, such as fungi and bacteria, and they vary in terms of their mode of existence; some are free-living, while others are symbiotic. Additionally, their additions serve a variety of functions by supplying the plant with nutrients; for instance, some facilitate the transformation of phosphorus, potassium, and certain microelements from an unprepared state to one that is amenable to absorption [3]. [5] Biofertilizers play a major role in increasing crop production, because increasing soil fertility over the long term is necessary to meet the global demand for food, as these microbes can interact with plants and crops and enhance them with the nitrogen, phosphorus, zinc, and other basic nutritional elements that plants need in the future. Growth

is considered environmentally friendly and available compared to chemical fertilizers that are harmful to the environment and are expensive (Nosheen et al., 2021). Although organic nitrogen is mineralized, it is useless to the plant because it is converted to mineral nitrogen [6] showed in their study of soil type and the addition of DMPP to inhibit the nitrification process that adding nitrogen at a rate of 0.25 grams of N per kg of soil with DMPP found that the moisture content, the degree of soil interaction, the amount of organic matter, and the soil texture significantly affected the rate of inhibition of the nitrification process. Nitrification and reducing nitrogen loss, which was added as urea in the presence of DMPP. [7]. In order to increase the efficacy of nitrogen fertilizer use, certain technologies have a tendency to employ slow-decomposing fertilizers or fertilizers containing microorganisms that impede the nitrification process during decomposition [8].

A study conducted by [9] examined the efficacy of incorporating the nitrification inhibitor 3, 4-dimethylpyrazol-phosphate (DMPP) and incubating nine different types of soils for a duration of 28 days in order to mitigate nitrogen loss. The findings indicated that 3, 4-Dimethylpyrazole-phosphate (DMPP), a nitrification inhibitor, exhibited a 68% reduction in nitrification bacteria activity. Moreover, the specific outcomes were contingent upon the soil type. [10] demonstrated through a study on cauliflower plants to determine the effect of nitrogen with *Azotobacter* and *Azospirillum* biofertilizers, with the following combination (120 kg.ha⁻¹ of nitrogen and 2 kg of biofertilizer) giving the best results, as it led to a significant increase in morphological characteristics and quality

compared to By applying nitrogen without biofertilizer, the maximum stem height of 18.72 cm, head diameter of 22.62 cm, head weight of 65.68 grams, and total yield of 18.3 tons were recorded. Hectare. Organic fertilizers are a product of plant, animal, or industrial-agricultural origin, which when added to the soil improves soil fertility, increases crop productivity and product quality, and ensures high yields and quality of vegetables. Studies have shown that organic fertilization has a positive result in the growth of vegetables. Organic fertilizers are generally found in solid form. Liquid and solid fertilizers are often added before planting [11,12]. [13] Showed that using organic fertilization with broccoli plants gave a significant effect on the percentage of protein, carbohydrates, and vitamin C content of the tablets compared to the control treatment. He obtained the same results .[14] Biofertilizers are important in reducing the addition of

chemical fertilizers by at least 25%, in addition to their importance in decomposing organic waste and their role in the secretion of some enzymes, growth regulators, and plant hormones, and are also useful in maintaining good soil.

2-Materials and Methods

The field experiment was conducted under the conditions of Babil Governorate during the agricultural season 2023-2024 in one of the private fields in the Al-Azawia area to study the effect of organic and biological fertilization on the growth and yield of Romanesco cauliflower plants. A soil sample was taken at a depth of 30 cm after scraping the surface layer. Several samples were mixed to obtain a representative sample of the field accurately. The samples were analyzed in the laboratory of the College of Agriculture/ Al-Qasim Green University, and the results are shown in Table (1).

Table 1. Some chemical and physical characteristics of field soil before planting

Traits	Units	Value
pH		8.0
Electrical conductivity	Ds/m ³	4.5
Organic matter	g. kg	11.3
Ready nitrogen	g. kg	13.4
Ready phosphorus	g. kg	5.6
Ready potassium	g. kg	192.0
Bulk density	g. cm ³	1.13
the sand	g. kg	600
Alluvial	g. kg	245
Clay	kg. kg	155
textuer		Silty loam

The experiment used the Randomized Complete Block Design (RCBD) with three replications. The experiment included two factors: two varieties of Romanesco cauliflower (6086 and Sow) and the biofertilizer factor (Control without addition - Bio health addition 10 kg/ha - Novatec21 addition 300 kg/ha). There were 9 experimental units in three replications, and

each unit was a plot with a length of 3.5 m, a width of 1 m, and 14 plants per unit with a spacing of 50 cm between plants. There was a 1 m space between each experimental unit and a 1.5 m space between blocks. Drip irrigation was used as the basis for the irrigation process. The treatments were compared using the Least Significant Difference (L.S.D) at a significance level of 0.05%.

Table 2. Shows the readiness content of materials for the treatments used.

Content of material availability	Units	Quantity
Bio health		
Trichoderma hazerinum Bacillus subtilis	%	01
Humic acid	%	53
Marine algae	%	3
moisture	%	01-01
Organic materials	%	43
Water-soluble potassium (K ₂ O)	%	00
Novatec 21		
Ammonium nitrogen	%	00
Sulfur (water soluble)	%	02
Dimethylpyrazole phosphate	%	1.6

3-Results and Discussion

From Table (3), we notice the superiority of the 6086 variety in all vegetative traits, as it recorded the highest average in plant height (96.20 cm), number of leaves (24.306 leaves.plant⁻¹), dry matter percentage (21.03%), chlorophyll percentage (64.7%), and leaf area (7344 cm²), compared to the Sow variety which gave the lowest rates in all traits. The same table indicated that biofertilization had a significant effect on plant height, number of leaves, dry matter percentage, chlorophyll content, and leaf area, as the Novatec21 fertilizer achieved the

highest average plant height (91.90 cm), number of leaves (24.292), leaf area (7781 cm²), dry matter percentage (22.11), and chlorophyll percentage (64.3) compared to the control treatment, which recorded the lowest average plant height (87.29 cm), number of leaves (23.889), leaf area (6380 cm²), dry matter percentage (20.60), and chlorophyll percentage (59.1). The table's second interaction also showed a significant superiority between the variety and the biofertilizer, as the interaction between the 6806 variety and the Novatec21 biofertilizer

achieved the highest significant average in plant height (97.86 cm), number of leaves (24.583 leaves.plant⁻¹), dry matter percentage (22.24%), chlorophyll content (66.0), and leaf area (7903 cm²).

Table 3. The effect of organic and biofertilization and their interaction on vegetative traits.

Biofertilizer	Plant height (cm)	Number of leaves	Dry Matter%	Chlorophyll 100g/mg	Leaves area (cm ²)
control	87.29	23.889	20.60	59.1	6380
Bio health	89.61	24.403	21.35	63.9	7365
Novatec21	91.90	24.292	22.11	64.3	7781
L.S.D.0.05	1.515	0.3721	1.146	5.08	436.8
verities					
8606	96.20	24.306	21.68	64.7	7344
Sow	83.00	24.083	21.03	60.2	7007
L.S.D.0.05	2.303	0.5896	0.681	11.20	1011.1
interaction					
A1B0	94.14	23.833	18.95	53.5	6751
A2B1	96.61	24.583	22.13	64.7	7378
A1B2	97.86	24.500	22.21	66.0	7903
A2B0	80.44	23.944	20.24	54.7	6010
A1B1	82.61	24.222	21.58	63.2	7351
A2B2	85.94	24.083	22.24	63.6	7659
L.S.D.0.05	2.125	0.5312	1.359	8.78	782.8

We notice from Table (4) the presence of significant differences in, as the Sow variety excelled significantly in the percentage of calcium, sulfur, and magnesium, giving the highest rate (0.2246%, 0.676%, and 0.208%) respectively. The Sow variety also excelled in the weight of the floral disc (928.3 g plant⁻¹) and the total yield (37132 kg/ha⁻¹) compared to variety 8606, which recorded the least significant difference, giving the lowest total yield of (34070 kg/ha⁻¹). Table (4) shows that biofertilization had a significant impact on the percentage of calcium, sulfur, magnesium,

weight of the floral disc, and total yield. Novatec21 fertilizer achieved the highest average percentage of calcium (0.2537%), sulfur (0.882%), magnesium (0.266%), weight of the floral disc (975.3), and total yield (39013) compared to the comparison treatment which recorded the lowest average percentage of calcium (0.0976%), sulfur (0.257%), magnesium (0.086%), weight of the floral disc (817.2), and total yield (32687). The interaction between the variety and biofertilizer showed superiority compared to the interaction between the Sow variety and

the biofertilizer Novatec21, giving the highest significant difference in the percentage of the floral disc, and total yield (0.1667%, 0.912%, 0.356%, 972.2, and 38889) respectively compared to the interaction between the first variety and the comparison

calcium, sulfur, magnesium, weight of of the biofertilizer, which showed the least significant difference in all traits.

DM%= Dry Matter%

Table (4) Effect of organic and biological fertilization and their interaction on the percentage of calcium, sulfur, and magnesium, and the weight of the flower disk (g/plant⁻¹) and the total yield (kg/hectare⁻¹).

Biofertilizer	Ca%	S%	Mg%	Weight of the flower head (g. plant ⁻¹)	Total yield Kg ha ⁻¹
control	0.0976	0.257	0.086	817.2	32687
Bio health	0.2113	0.677	0.149	877.6	35102
Novatec21	0.2537	0.882	0.266	975.3	39013
L.S.D.0.05	0.0218	0.0979	0.0767	9.89	3957
varieties					
8606	0.1505	0.534	0.126	851.7	34070
Sow	0.2246	0.676	0.208	928.3	37132
L.S.D.0.05	0.0465	0.0997	0.1289	29.80	11919
interaction					
A1B0	0.0804	0.211	0.064	755.0	30200
A2B1	0.2524	0.540	0.137	821.8	32871
A1B2	0.3408	0.852	0.176	978.4	39138
A2B0	0.1147	0.302	0.107	879.3	35173
A1B1	0.1702	0.814	0.161	933.3	37333
A2B2	0.1667	0.912	0.356	972.2	38889
L.S.D.0.05	0.03684	0.1229	0.1125	29.16	11665

From the results of tables (3 and 4), it is noticeable that cultivar 8606 excels significantly in plant height, leaf number, dry matter, chlorophyll content, and leaf area compared to the Sow cultivar, which showed the least significant difference in all studied traits. This is attributed to the nature of the cultivar's composition and its suitability for

the growing conditions in the area, consistent with Al-Shamri et al. (2016) , Al-Ajoud (2019), Manea (2017), Manea & Abbas (2018) and Al Gubour et.al. (2023) in their studies on different hybrids of cauliflower. The results of tables (3 and 4) also indicate that organic fertilization significantly outperformed in all vegetative and yield traits, with the treatment

of Novatec21 fertilizer showing the highest results in plant height, leaf number, dry matter percentage, chlorophyll quantity, leaf area, calcium, sulfur, magnesium, dry matter, flower head weight, and total yield compared to the control treatment without additives, which had the least impact. This is in line with Subdi et al. (2019), who demonstrated the superiority of nitrogen fertilizers with organic fertilizer in promoting cauliflower plant growth, with the highest plant height recorded at 35 days after planting (9.011) and 60 days after planting (22.74), while leaf area measurements were 250.3 cm and 1035 cm, head diameter was 17.53 cm, stem diameter was 3.30 cm, head weight was 1.133 kg, and total yield was 41.53 tons per hectare. Additionally, the results in tables (3 and 4) show that the interaction between variety and biological fertilization significantly outperforms the interaction between 8606 variety compost and Novatec21 fertilizer in plant height, leaf number, dry matter percentage, chlorophyll quantity, leaf area, calcium, sulfur, magnesium, and dry matter.

4-Conclusion

1- The genetic composition of the variety significantly influences vegetative growth traits, yield traits, and chemical traits, with variety 8606 outperforming in providing the best results for most vegetative growth traits, yield traits, and chemical traits.

2- Encouraging farmers and researchers to use Bio fertilizer to prepare NPK and increase soil fertility.

3- Using Bio fertilizer at low levels of mineral fertilizer in a dual-intercropping manner to increase readiness and productivity.

4- Expanding the cultivation of Romanesco cauliflower in the presence of Bio fertilizer.

5- Recommending the widespread use of Bio fertilizer Novatec21 in Babil Governorate to increase the plant's nitrogen benefit.

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