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RESEARCH ARTICLE

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Bio stimulant-Driven Improvement of Growth, Yield, and Phytochemical Traits in White and Red Cabbage

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ABSTRACT

White and red cabbages (Brassica oleracea var. capitata) are economically and nutritionally significant cruciferous vegetables. Optimizing agronomic practices to enhance their growth, yield, and biochemical quality is essential for sustainable production. To this end, a field experiment was conducted during the 2024 growing season to evaluate the comparative response of white and red cabbage varieties to foliar applications of two bio-stimulators: Viviter Veg and Pow Humus. The study utilized a Randomized Complete Block Design (RCBD) with a factorial arrangement and three replications. Treatments included three concentrations of Viviter Veg (0, 10, and 20 ml/L) and Pow Humus (0, 4, and 8 g/L), applied three times at 15-day intervals commencing three weeks after transplanting. Parameters assessed included plant height, head fresh and dry weight, total yield, chlorophyll content (SPAD), as well as carbohydrate and phenolic content. Analysis of variance revealed that bio-stimulator application significantly improved all vegetative and biochemical traits compared to the control. Notably, the white cabbage variety demonstrated significantly superior performance over the red variety across most parameters, recording a higher total yield of (37.50 t/ha) compared to (24.12 t/ha) for red cabbage. Furthermore, Pow Humus exhibited a greater impact on yield characteristics than Viviter Veg. The highest values for most parameters were recorded with the application of Pow Humus at 8 g/L, which achieved a head fresh weight of (750.24 g) and a total yield of (37.50 t/ha), followed by Viviter Veg at 20 ml/L. These findings suggest that the foliar application of Pow Humus at 8 g/L is an effective strategy for maximizing the productivity and nutritional quality of cabbage, particularly for the white variety.

***Keywords*:** Cabbage, Variety, Bio-stimulator, Yield, Quality.

INTRODUCTION

Cabbage (*Brassica oleracea* L. var. *capitata*) is a prominent member of the Cruciferae family and remains one of the most economically significant leafy vegetables globally. Cultivated widely as a cool-season crop, it is highly valued for its shallow-rooted agronomic traits and its large, leafy head [1]. In recent years, consumer demand has shifted toward high-quality vegetable products that offer both sensory appeal and nutritional density [2]. Among the various cultivars, white and red cabbages are the most extensively grown, yet they differ significantly in their morphological characteristics and consumer preference. Understanding the agronomic potential of these varieties is essential for maintaining a consistent market supply [3].

Beyond its role as a staple food, cabbage is recognized as a functional food source rich in dietary fiber, minerals, and bioactive non-nutrient compounds. It serves as a vital reservoir of phytochemicals, particularly glucosinolates, flavonoids, and phenolic acids (polyphenols) [4]. These secondary metabolites act as potent antioxidants that mitigate oxidative stress and are associated with reduced risks of chronic diseases, including gastrointestinal disorders and cancer [5]. However, the concentration of these beneficial compounds is not static; it is heavily influenced by genotype (variety) and environmental growing conditions, necessitating agronomic interventions to optimize nutritional quality [6].

To enhance crop quality and yield sustainability, modern agriculture has increasingly turned to plant bio-stimulants as an alternative to excessive chemical fertilization. Bio-stimulants are defined as formulations of compounds, substances, and microorganisms that are applied to plants or soils to regulate and enhance the crop's physiological processes [7,8]. Unlike traditional fertilizers, they function not by directly supplying nutrients, but by improving nutrient use efficiency, stimulating photosynthesis, and bolstering tolerance to abiotic stresses [9].

Bio-stimulants encompass a wide range of organic inputs, including humic substances and amino acid-based products. Humic compounds (such as Pow Humus) are known to improve soil structure and root development, thereby increasing nutrient availability and uptake [10]. Similarly, amino acid-enriched stimulators (such as Viviter Veg) play a crucial role in protein synthesis and hormonal regulation, triggering metabolic processes that lead to improved vegetative growth and secondary metabolite accumulation [11].

Despite the documented benefits of bio-stimulants in general vegetable production, there is a scarcity of comparative studies evaluating the specific interaction between distinct cabbage varieties and different types of bio-stimulators. Specifically, the comparative efficacy of humic-based versus amino acid-based bio-stimulants on the physiological and biochemical traits of white versus red cabbage remains under-explored. Therefore, this study aims to evaluate and compare the effects of foliar applications of Viviter Veg and Pow Humus on the growth characteristics, yield, and phytochemical content of white and red cabbage varieties under field conditions.

Materials and Methods

The study was carried out during the growing season of 2024-2025 in a private nursery in Erbil. The white and red cabbage seedlings were obtained From ARD company for seedling production.

The experiment consists of 12 treatments using white cabbage (C1) (Green Coronet cv.) and the red one (C2) was (Hannar cv.), and two types of bio-stimulators Viviter Veg (F1) and Pow Humus (F2) each with tree concentrations (0, 10, and 20) ml/L and (0, 4 and 8) g/L respectively. In each plot there were 2 rows and each contained 2 plants, therefore the total numbers of plants were 120 plants. The distance between row to row and plant to plant within the row was 50cm and 40 cm respectively. The spray was carried out at three times, with 15-day intervals started from third week after transplanting. The experiment was randomized complete block design RCBD. About sixty days after transplanting

growth and yield measurements were recorded randomly from selected plants which included, plant height (cm), head fresh and dry weight (g), total yield (t ha^{-1}), leaf chlorophyll content SPAD. Regarding quality indices and antioxidant content carbohydrate and phenol content were determined. Total soluble carbohydrates were quantified using the anthrone method as described by [12]. The Folin reagent method was used to measure the total phenol content in cabbage heads [13]. Data were analyzed by the SAS institute program (SAS, 2014). Duncan's multiple range tests were used to compare differences among the followed a completely randomized design at the level of probability 0.05.

The treatments were arranged as follow:

T1 White cabbage + 0 ml/L Viviter Veg
T2 White cabbage + 10 ml/L Viviter Veg
T3 White cabbage + 20 ml/L Viviter Veg
T4 White cabbage + 4 g/L Pow Humus
T5 White cabbage + 8 g/L Pow Humus
T6 Red cabbage + 0 ml/L Viviter Veg
T7 Red cabbage + 10 ml/L Viviter Veg
T8 Red cabbage + 20 ml/L Viviter Veg
T9 Red cabbage + 4 g/L Pow Humus
T10 Red cabbage + 8 g/L Pow Humus

T: Treatment

Table 1 Some chemical and physical properties of the soil at depth (0-30 cm):

Particle size distribution			Texture class	pH	EC	Organic matter
Sand	Silt	Clay				
11.7	41.8	46.5	Silty clay	7.2	0.3	0.9

Result and Discussion

Effect of selected bio-stimulators on plant height of white and red cabbage varieties:

Table 1 and Figure 1 (a, b) illustrate the significant variations in plant height influenced by cabbage variety and bio-stimulator treatments. A substantial difference was observed between the two varieties; the white cabbage (C1) demonstrated superior vegetative growth, recording a significantly higher mean plant height of (23.94 cm) compared to (21.48 cm) for the red variety (C2).

Regarding the bio-stimulator treatments, the application of Pow Humus at 8 g/L proved to be the most effective treatment for maximizing vertical growth. This concentration resulted in the highest plant height of (29.08 cm) in white cabbage, representing a significant increase over the control treatment (19.31 cm). Similarly, in the red variety, the 8 g/L Pow Humus treatment achieved the maximum height of (25.31 cm). While Viviter Veg also improved growth compared to the control, with its optimum concentration (20 ml/L) yielding a height of (25.66 cm) in white cabbage, the humic-based treatment (Pow Humus) consistently outperformed the amino-acid based treatment (Viviter Veg) across both varieties.The observed enhancement in plant height can be attributed to the physiological role of humic substances in stimulating cell elongation and improving root system architecture. Humic acids are known to facilitate nutrient uptake, particularly nitrogen, which is essential for vegetative growth. This interpretation is supported by [14], who noted that humic substances act as auxin-like bio-stimulants that promote root development and nutrient absorption. These findings align with [15], who reported that foliar spraying of humic acid significantly increased plant height in red cabbage by enhancing metabolic activity and photosynthesis. Furthermore, the positive response to Viviter Veg aligns with [16], who observed that bio-stimulants containing amino acids and seaweed extracts improve vegetative parameters by mitigating abiotic stress; however, our results suggest that under the specific conditions of this study, the mineral-chelating properties of Pow Humus had a more pronounced effect on stem elongation than Viviter Veg.

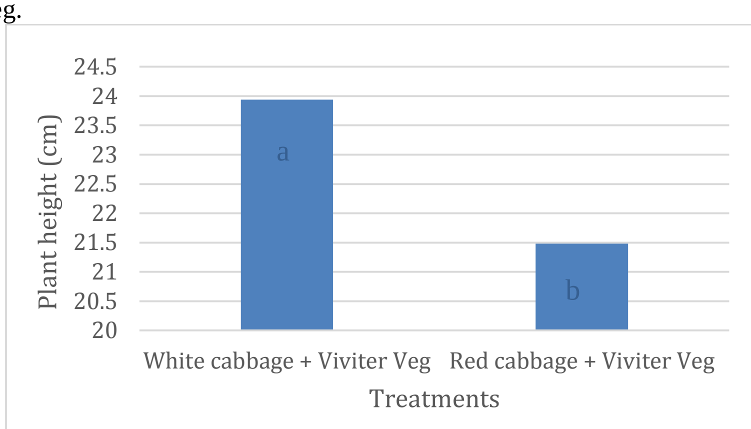

Figure 1, a. Effect of Viviter Veg bio-stimulator on plant height of white and red cabbage varieties
The columns with different letters indicate significant difference at P≤0.05 according to the Duncan's multiple range test.

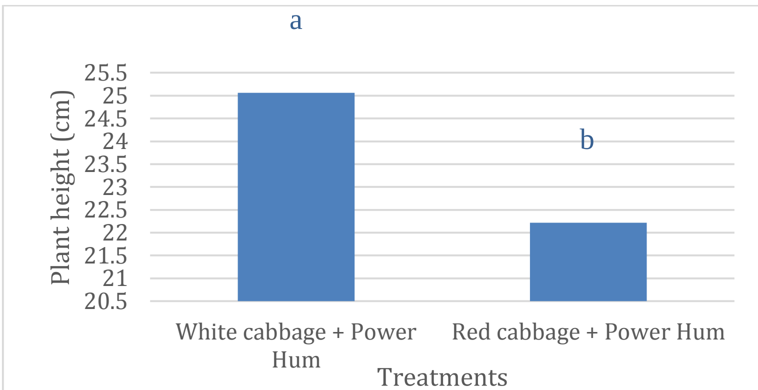

Figure 1, b. Effect of Pow Humus bio-stimulator on plant height of white and red cabbage varieties
The columns with different letters indicate significant difference at P≤0.05 according to the Duncan's multiple range test.

Table 1: Effect of different concentrations of selected stimulator on plant height of white and red cabbage varieties:

Treatments	Plant height (cm)	Mean
T_1 White cabbage + 0 ml/L Viviter Veg	19.31 g	23.94 a
T_2 White cabbage + 10 ml/L Viviter Veg	23.48 d	
T_3 White cabbage + 20 ml/L Viviter Veg	25.66 c	
T_4 White cabbage + 4 g/L Pow Humus	26.80 b	
T_5 White cabbage + 8 g/L Pow Humus	29.08 a	
T_6 Red cabbage + 0 ml/L Viviter Veg	18.05 h	21.48 b
T_7 Red cabbage + 10 ml/L Viviter Veg	21.50 f	
T_8 Red cabbage + 20 ml/L Viviter Veg	27.70 e	
T_9 Red cabbage + 4 g/L Pow Humus	23.30 d	
T_{10} Red cabbage + 8 g/L Pow Humus	25.31 c	

Means in the same column followed by different letters are significantly different according to Duncan's Multiple Range Test ($p < 0.05$).

Effect of selected bio-stimulators on head fresh weight, head dry weight and total yield of white and red cabbage varieties:

The data presented in Table 2 clearly demonstrates that the application of bio-stimulators (Pow Humus and Viviter Veg) significantly enhances the vegetative growth and yield parameters of cabbage varieties compared to the control. The maximum head fresh weight (750.24 g) and dry weight (74.20 g) were recorded in white cabbage (C1) treated with Pow Humus at 8 g/L. Consequently, this treatment resulted in the highest total yield of (37.50 t / ha). Similarly, for red cabbage (C2), the application of Pow Humus (8 g/L) resulted in the maximum yield (24.12 t / ha), a significant increase over the lowest yield observed in the control treatment (11.05 t ha^{-1}).

The physiological basis for the superior performance of Pow Humus (Humic Acid) can be attributed to its hormone-like activity. Humic substances have been shown to stimulate the plasma membrane activity, which promotes cell expansion and facilitates nutrient uptake (17). This mechanism likely enhanced the root system architecture, allowing for greater absorption of water and mineral nutrients, thereby fueling the significant increase in biomass accumulation observed in the (37.50 t / ha) yield of white cabbage. Furthermore, humic acids improve photosynthetic efficiency and chlorophyll content (18), which directly correlates to the higher dry matter accumulation (74.20 g) by increasing carbon assimilation rates.

Regarding the Viviter Veg stimulator, the significant increase in head fresh weight (433.98 g) in red cabbage at the 20 ml/L concentration suggests a dose-dependent improvement in metabolic function. As a vegetative bio-stimulator (likely containing amino acids or peptide complexes), it reduces the energy cost of protein synthesis for the plant. By providing ready-made building blocks for proteins, the plant can redirect metabolic energy toward rapid cell division and expansion (19, 20). The significant differences observed at the higher concentration (20 ml/L) compared to the control confirm that adequate dosage is critical for triggering these physiological signaling pathways.

The results consistently show that the white cabbage variety (C1) is significantly superior to the red variety (C2) regarding fresh weight, dry weight, and total yield across all treatments. As shown in Figure 2(a) and 2(b), the interaction effects indicate that while both varieties respond positively to bio-stimulators, C1 possesses a higher genetic potential for biomass accumulation.

Physiologically, this variation may be explained by Metabolic trade-off. Red cabbage (C2) requires significant metabolic energy and carbon skeletons to synthesize anthocyanins (the pigments responsible for its red color). This diversion of photosynthates toward secondary metabolite production may occur at the expense of primary vegetative growth, resulting in lower fresh weights (maximum 482.39 g) compared to the non-pigmented white variety (750.24 g) (21). Additionally, the inherent genetic differences in cell size and leaf water potential between the two cultivars likely contribute to the significant variation in total yield potential (37.50 t /ha) for C1 vs. 24.12 t/ ha) for C2).

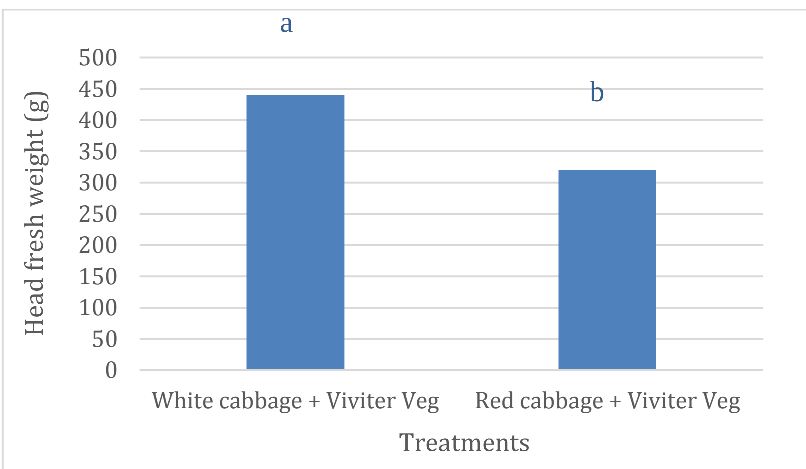

Figure 2, a. Combination effect of Viviter Veg and cabbage varieties on head fresh weight (g)

The columns with different letters indicate significant difference at P≤0.05 according to the Duncan's multiple range test.

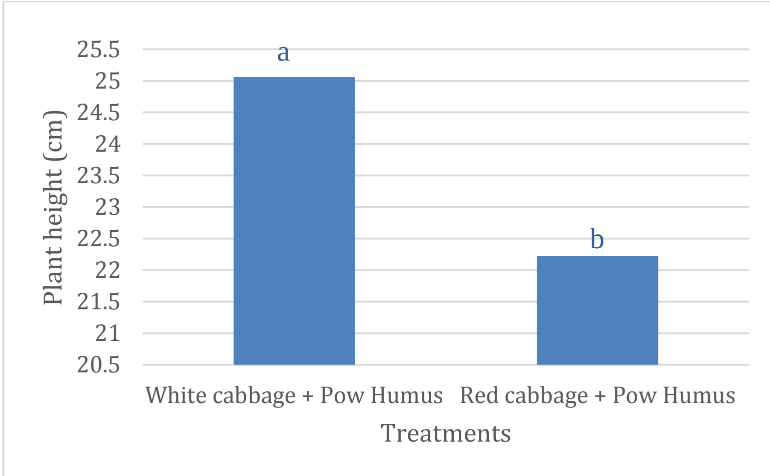

Figure 2, b. Combination effect of Pow Humus and cabbage varieties on head fresh weight (g)
The columns with different letters indicate significant difference at P≤0.05 according to the Duncan's multiple range test.

The interaction data presented in Figure 3 (a and b) underscores a distinct synergistic effect between the variety and the bio-stimulator applied. While both varieties benefited from the treatments, the magnitude of the response was significantly governed by the genotype. White cabbage (C1) demonstrated a superior physiological capacity to utilize the bio-stimulators, achieving a peak total yield of 29.1 t /ha) under the Pow Humus treatment. In contrast, red cabbage (C2) was less responsive, achieving a maximum yield of (18.76 t/ ha) under the same conditions.

These results align with the findings of (22), who reported significant increases in cabbage yield parameters following bio-stimulator application. As noted by (22), bio-stimulators often enhance the permeability of cell membranes; in our study, this likely facilitated the rapid uptake of macronutrients required to sustain the significantly higher fresh weights (up to 750.24 g) recorded in the treated plants.

Furthermore, the positive response to Viviter Veg mirrors the effects of seaweed extracts reported by (23). Just as seaweed extracts contain cytokinins and auxins that stimulate cell division, the significant difference between the control yield (11.05 t /ha).

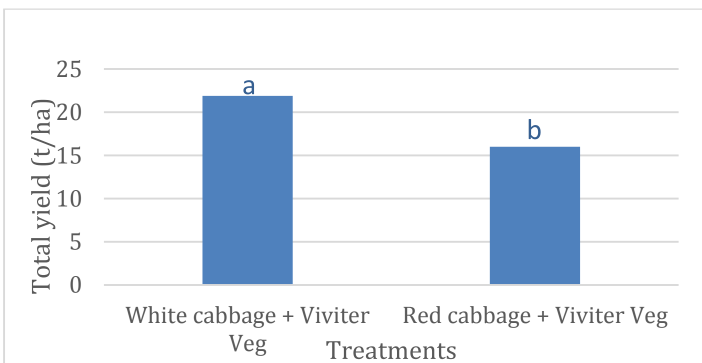

Figure 3, a. Combination effect of Viviter Veg and cabbage varieties on total yield (t/ha)
The columns with different letters indicate significant difference at P≤0.05 according to the Duncan's multiple range test.

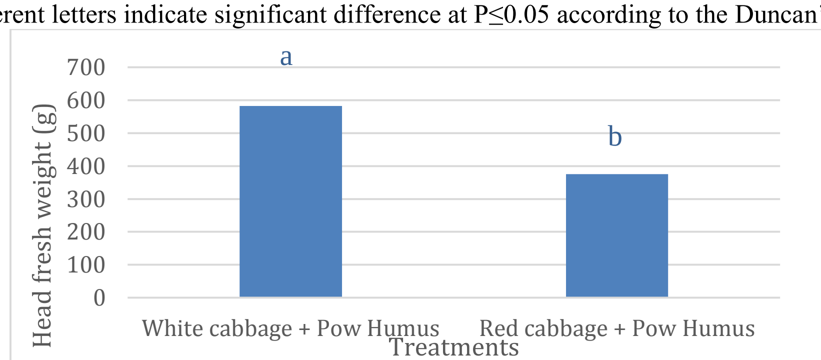

Figure 3, b. Combination effect of Pow Humus and cabbage varieties on total yield (t/ha)
The columns with different letters indicate significant difference at P≤0.05 according to the Duncan's multiple range test.

Table 2: Effect of different concentrations of selected bio-stimulators on some yield parameters of white and red cabbage varieties:

Treatments	Head fresh weight (g)	Mean	Head dry weight (g)	Mean	Total yield (t ha^{-1})	Mean
T_1 White cabbage + 0 ml/L Viviter Veg	355.69 f	510.89 a	32.84 e	47.67 a	17.78 f	25.51 a
T_2 White cabbage + 10 ml/L Viviter Veg	433.59 e		40.47 d		21.52 e	
T_3 White cabbage + 20 ml/L Viviter Veg	529.49 c		48.59 c		26.47 c	
T_4 White cabbage + 4 g/L Pow Humus	640.70 b		57.09 b		32.03 b	
T_5 White cabbage + 8 g/L Pow Humus	750.24 a		74.20 a		37.50 a	
T_6 Red cabbage + 0 ml/L Viviter Veg	221.06 h	347.91 b	20.43 g	29.41 b	11.05 h	17.39 b
T_7 Red cabbage + 10 ml/L Viviter Veg	306.43 g		24.19 f		15.31 g	
T_8 Red cabbage + 20 ml/L Viviter Veg	433.98 e		33.61 e		21.69 e	
T_9 Red cabbage + 4 g/L Pow Humus	422.59 e		39.12 d		21.13 e	
T_{10} Red cabbage + 8 g/L Pow Humus	482.39 d		38.69 d		24.12 d	

Means in the same column followed by different letters are significantly different according to Duncan's Multiple Range Test ($p < 0.05$).

Effect of selected bio-stimulators on Chlorophyll content SPAD of white and red cabbage varieties:

The data in Table 3 demonstrates that bio-stimulator application significantly enhances leaf chlorophyll concentration, a critical determinant of photosynthetic capacity. The highest physiological response was observed in the white cabbage variety (C1), where the application of Viviter Veg (20 ml/L) and Pow Humus (8 g/L) resulted in peak SPAD values of 72.60 and 72.27, respectively. These values were significantly superior to the control and other treatments.

Physiologically, the efficacy of Pow Humus at 8 g/L can be attributed to the ability of humic substances to chelate essential cations, particularly Magnesium (Mg^{2+}) and Iron (Fe^{2+}), and facilitate their transport across the root membrane. Since Magnesium is the central atom of the chlorophyll porphyrin ring, its increased bioavailability directly supports higher chlorophyll synthesis rates (24). Nardi,2002).

Regarding Viviter Veg, the peak value of 72.60 SPAD suggests that the exogenous supply of amino acids acted as direct metabolic precursors. Amino acids such as Glutamate are fundamental to the chlorophyll biosynthesis pathway. By providing these precursors directly, the plant can bypass energy-intensive synthesis steps, allowing for rapid pigment accumulation even under field conditions (25).

The analysis of mean data confirms the significant superiority of White Cabbage (C1) over Red Cabbage (C2) regarding SPAD values. While C2 showed a positive response to Pow Humus (8 g/L), it consistently recorded lower values than C1. This discrepancy is likely linked to optical masking and resource allocation. Red cabbage contains high concentrations of anthocyanins in the vacuole; these pigments may interfere with the optical transmission used by the SPAD meter or, more significantly, represent a metabolic trade-off where carbon flux is directed toward protective flavonoids rather than maximizing chlorophyll density.

These observations align with and extend the findings of (26) [17], who reported that bio-stimulators increase chlorophyll content. However, while (26) [17] focused on the general maintenance of greenness, our data quantifies this enhancement, showing that optimal concentrations can push SPAD values to 72.60. This supports the hypothesis that bio-stimulators do not merely prevent chlorophyll degradation (senescence) but actively stimulate the photosynthetic apparatus, leading to the higher "source" activity required to support the yield increases discussed in the previous section.

Table 3: Effect of different concentrations of selected stimulator on chlorophyll content SPAD of white and red cabbage

Treatments	Chlorophyll content SPAD	Mean
T_1 White cabbage + 0 ml/L Viviter Veg	45.34 f	59.50 a
T_2 White cabbage + 10 ml/L Viviter Veg	56.16 e	
T_3 White cabbage + 20 ml/L Viviter Veg	72.27 a	
T_4 White cabbage + 4 g/L Pow Humus	65.27 c	
T_5 White cabbage + 8 g/L Pow Humus	72.60 a	
T_6 Red cabbage + 0 ml/L Viviter Veg	47.29 f	57.97 b
T_7 Red cabbage + 10 ml/L Viviter Veg	55.43 e	
T_8 Red cabbage + 20 ml/L Viviter Veg	60.63 d	
T_9 Red cabbage + 4 g/L Pow Humus	68.36 b	
T_{10} Red cabbage + 8 g/L Pow Humus	68.82 b	

Means in the same column followed by different letters are significantly different according to Duncan's Multiple Range Test ($p < 0.05$).

Effect of selected bio-stimulators on carbohydrate content of white and red cabbage varieties:

The data in Table 4 reveals that the application of bio-stimulators induces a significant metabolic shift toward carbohydrate accumulation in cabbage heads. The treatment effects were pronounced, with the maximum carbohydrate content of 278 mg/100g recorded in Red Cabbage (C2) treated with Pow Humus (8 g/L). This represents a substantial increase over the minimum baseline of 132 mg/100g observed in the control treatment of White Cabbage (C1).

Physiologically, this surge in carbohydrate content correlates directly with the increased photosynthetic efficiency (SPAD values) discussed in the previous section. The bio-stimulators, particularly Pow Humus, appear to enhance source-to-sink translocation efficiency. Humic substances are known to stimulate the uptake of mineral nutrient and by optimizing this transport mechanism, the plant can store more energy as carbohydrates rather than expending it solely on respiration. An interesting physiological distinction arises when comparing varieties. While White Cabbage (C1) produced higher fresh weights (yield), Red Cabbage (C2) recorded the highest carbohydrate concentration (278 mg/100g). This can be explained by the specific metabolic requirements of anthocyanin synthesis.

These findings corroborate the work of (27) Wielgusz et al. (2021) who noted that application of various botanical extracts to cabbage seedlings showed different impacts, with some extracts increasing photosynthetic pigments (and thus potentially leading to more carbohydrates).

Table 4: Effect of selected bio-stimulators on carbohydrate content of white and red cabbage varieties:

Treatments	Carbohydrate (mg/100g)
T_1 White cabbage + 0 ml/L Viviter Veg	132
T_2 White cabbage + 10 ml/L Viviter Veg	142
T_3 White cabbage + 20 ml/L Viviter Veg	139
T_4 White cabbage + 4 g/L Pow Humus	147
T_5 White cabbage + 8 g/L Pow Humus	154
T_6 Red cabbage + 0 ml/L Viviter Veg	135
T_7 Red cabbage + 10 ml/L Viviter Veg	155
T_8 Red cabbage + 20 ml/L Viviter Veg	174
T_9 Red cabbage + 4 g/L Pow Humus	188
T_{10} Red cabbage + 8 g/L Pow Humus	278

Effect of selected bio-stimulators on Phenol compounds of white and red cabbage varieties:

The provided data demonstrates a clear genotype-dependent accumulation of phenolic compounds, which is enhanced by the application of bio-stimulators. The stark difference between the two varieties (C1 white cabbage and C2 red cabbage) reflects established physiological differences in how these plants manage secondary metabolites. The most significant upregulation was observed with the application of Pow Humus (8 g/L). In White Cabbage (C1), phenolic content increased from a baseline of (93.00 mg/100g) in the control to (129.00 mg/100g). However, the response was even more dramatic in Red Cabbage (C2), where the same treatment elevated phenolic content from (97.5 mg/100g) to a maximum value of (185.00 mg/100g), representing a near nearly two-fold increase.

The observation that red cabbage (C2) naturally has significantly higher phenolic content than white cabbage (C1) in control conditions (97.5 mg/100g vs. 93.00 mg/100g) is a primary indicator of genetic control. Red cabbage is genetically predisposed to synthesize anthocyanins, a major class of phenolic compounds responsible for its color, which are largely absent in white cabbage varieties.

Table 5: Effect of selected bio-stimulators on phenolic compounds of white and red cabbage varieties:

Treatments	Phenolic compound (mg/100g)
T_1 White cabbage + 0 ml/L Viviter Veg	93.00
T_2 White cabbage + 10 ml/L Viviter Veg	111
T_3 White cabbage + 20 ml/L Viviter Veg	115
T_4 White cabbage + 4 g/L Pow Humus	113
T_5 White cabbage + 8 g/L Pow Humus	129
T_6 Red cabbage + 0 ml/L Viviter Veg	97.5
T_7 Red cabbage + 10 ml/L Viviter Veg	149
T_8 Red cabbage + 20 ml/L Viviter Veg	136
T_9 Red cabbage + 4 g/L Pow Humus	174
T_{10} Red cabbage + 8 g/L Pow Humus	185

These findings are consistent with the work of (28) [18], who studied the effect of three commercial extracts on phytochemical content in cabbage plants. Total phenolic content was higher in all seaweed treated plants in comparison with control treatment. Furthermore, this validates the observations of (29) [19] who noted that bio stimulant application in different species (cabbage, broccoli, mustard and rapeseed) increased plant growth, yield parameters and phenolic compounds.

Conclusions

At the outcome of the study, it is concluded that foliar application of bio-stimulators proved to be a highly effective strategy for enhancing cabbage productivity. Pow Humus demonstrated superior performance over Viviter Veg across most parameters. White Cabbage (Variety C1), demonstrated the highest genetic potential for biomass accumulation. The application of Pow Humus (8 g/L) resulted in the maximum head fresh weight (750.24 g) and a peak total yield of 37.50 t /ha). Red Cabbage Variety C2 While lower in total yield (24.12 t/ ha) with Pow Humus (8 g/L), it significantly outperformed the control yield of (11.05 t /ha).

There is a distinct physiological trade-off between the two varieties. While White Cabbage is superior for total biomass (yield), Red Cabbage is superior for nutritional quality. Treatment with Pow Humus (8 g/L) maximized the accumulation of secondary metabolites in Red Cabbage, achieving the highest phenolic content (185.00 mg/100g) and carbohydrate content (278 mg/100g). This confirms that humic substances can actively stimulate the Phenylpropanoid pathway, enhancing the nutraceutical value of the crop.

Consumers are becoming more aware of the health benefits of vegetables, making it crucial to consistently study the phytochemicals in plants and how growth factors affect the antioxidant levels in various edible plant varieties. This includes shifting from traditional chemical use to organic alternatives, like plant extracts, will greatly benefit natural resources, the environment, and human health.

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دراسة مقارنة لتأثير نوعين من المحفزات الحيوية في نمو، حاصل وجودة اللهانة البيضاء والحمراء

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الخلاصة

تعتبر صنفي اللهانة البيضاء والحمراء ل (***Brassica oleracea var. capitata***) من الخضروات الصليبية ذات القيمة العالية وذلك لمذاقها المميز، محتواها الغذائي العالي وفوائدها الصحية المتعددة. في هذا السياق، أجريت التجربة الحقلية الحالية خلال موسم النمو لعام 2024. حيث صممت هذه التجربة باستخدام تصميم القطاعات العشوائية الكاملة (***RCBD***) العاملية بثلاث مكررات لتحديد كيفية تأثير الرش الورقي لنوعين من المحفزات الحيوية ***Viviter Veg*** و***Pow Humus*** و بثلاث تراكيز (0 و10 و20 مل / لتر) و (0 و4 و8 جم / لتر) لكل منهما على التوالي على ارتفاع النبات، وزن الرأس الطري، وزن الرأس الجاف، الحاصل الكلي ومحتوى الكلوروفيل ***SPAD*** بالإضافة إلى محتوى الكربوهيدرات والمركبات الفينولية لرأسي اللهانة البيضاء والحمراء.. تمت عملية الرش ثلاث مرات بدءًا من الأسبوع الثالث من الزراعة، بفاصل 15 يومًا بين رشة واخرى. وأظهرت النتائج أن ارتفاع النبات، وزن الرأس الطري، وزن الرأس الجاف، الحاصل الكلي، ومحتوى الكلوروفيل ***SPAD*** قد ازداد مقارنةً بالكونترول نتيجةً رش صنفي اللهانة البيضاء والحمراء بالمحفزات الحيوية.من ناحية أخرى، ازداد محتوى الكربوهيدرات والفينول أيضًا نتيجةً لاستخدام هذين النوعين من المحفزات الحيوية. وبالمقارنة بين صنفي اللهانة البيضاء والحمراء، تفوقت اللهانة البيضاء معنوياعلى اللهانة الحمراء في جميع الصفات المدروسة. بالإضافة إلى ذلك، كان تاثيرالمحفزالحيوي ***Pow Humus*** أكبرمن تأثير المحفزالحيوي ***Viviter Veg*** في زيادة قيم الخصائص المدروسة. ومن بين التركيزات المستخدمة في هذه التجربة،كلا التركيزين (***Pow Humus 8g/L***) و (***Viveter Veg 20 ml/L***)سجلا أعلى القيم لمعظم الصفات المدروسة**.**

الكلمات المفتاحية: لهانة، أصناف، المحفزات الحيوية، انتاج، النوعية.