Kirkuk University Journal for Agricultural Sciences
ISSN:2958-6585
https://kujas.uokirkuk.edu.iq

RESEARCH ARTICLE
https://doi.org. 10.58928/ku26.17216

Impact of Planting Date, Foliar Application of Boron and Vermwash on Vegetative Growth, Mineral Nutrients and Yield of Cauliflower (*Brassica Oleracea Var. Botrytis L.)*

Mariam Abdulrahman Mustafa[1] **Ghurbat Hassan Mohammed** [1]
[1]*Department of Horticulture, College of Agricultural Engineering Sciences, University of Duhok, Kurdistan region, IRAQ.*
*Corresponding Author: ghurbat.mohammed@uod.ac.

Received:17/08/2025 **Revised: 06/10/2025** **Accepted: 11/05/2026** **Published: 14/06/2026**

ABSTRACT

This study was carried out during growing season 2024-2025 in the plastic house (500 m2) at the Agricultural Research Directorate to study the impact of two planting date (15th August and 1st September), three levels of boron (0, 40 and 80 mg L-1) and three levels of vermiwash (0, 6 and 12ml L-1) on vegetative growth (plant height and leaf area), mineral nutrients (nitrogen percentage, phosphorous percentage and potassium percentage) and yield (average fresh weight of curd and total yield) of cauliflower plant. The experiment was implicated in a factorial Randomized Complete Block Design (RCBD). The results showed that the 1st September significantly enhanced plant height (cm), and leaves potassium%. The foliar application of 40 and 80 mg L-1 of boron significantly enhanced of plant height (cm), leaf area (cm2), leaves nitrogen%, leaves phosphorous%, leaves potassium%, average fresh weight of curd (kg plant-1) and total yield (kg unit-1). Similarly, vermiwash showed positive and significant effects on all studied parameters except leaf area (cm2) and leaves nitrogen%. The combined influence of two factors namely planting date and boron, planting date and vermiwash and boron and vermiwash had a significant impact on all vegetative growth and yield parameters. Notably, the interaction among 1st September, 80 mg l-1 boron and 12 ml l-1 vermiwash exhibited the most substantial effects, resulting in the highest plant height (cm), leaf area (cm2), average fresh weight of curd (kg plant-1) and total yield (kg unit-1).

***Keywords*:** Brassicaceae, mineral nutrients, organic fertilization, boron and cauliflower.

INTRODUCTION

Cauliflower (*brassica oleracea var. botrytis* L.) is an important vegetable crop that belongs to the Brassicaceae family. Whether eaten raw or cooked, or pickled [1]. It is a very rich source of dietary fiber, vitamin C, vitamin K, vitamin B6, folate, and pantothenic acid, and it is also an excellent source of protein, thiamin, riboflavin, phosphorus, potassium, and manganese. [2]. Additionally, it has therapeutic effects and medicinal qualities because to its high content of glycothicyanate, which effectively inhibits carcinogensis. [3].

An important factor in obtaining a higher yield is planting at the correct time. Different scientist has various opinion about when to grow cauliflower, and the results of this study change from one country to another. The impact of environmental factors on cauliflower development, yield, and quality is therefore confirmed by the broad regional variations in the transplanting dates of vegetable output [4].

Cauliflower needs a lot of minerals, particularly boron. Due its involvement in cell division boron is crucial for cauliflower growth and development, supporting in the elongation of roots and the formation of shoots. It is associated to a number of physiological functions, involving protein synthesis, hormone synthesis, sugar metabolism, calcium metabolism, and solute translocation [6]. In the plant meristem, boron is major for the growth and development of cells [7]. The uptake necessary plant nutrients from the soil, protein synthesis, sugar translocation, cell elongation and division, as well as metabolism of biomolecules such nucleic acid and carbohydrates, and the preservation of the structural integrity of plant membranes are all significantly affected by boron. Thus, all of these processes are impacted by a boron shortage [8]. Discovered that applying B, either as a soil application or foliar application, might overcome B shortage and enhance the growth and production of cauliflower [9]. According to [10] the boron dose has a substantial and positive correlation with the number of leaves, canopy cover, curd diameter, and curd production. hence, a large boron dose corresponds to a higher biological yield.

Pollution and soil deterioration have made sustainable agriculture a greater problem in today's society. Using organic manures, fertilizers, and more recently, organic nutrients with a biological base, are important practices in this kind of agriculture. Vermiwash is a naturally occurring nutrient that is produced as a byproduct of vermicompost unity. Vermiwash is showing promise as a tool [11]. In organic farming, it is a good source of plant nutrients because to its high content of dissolved

minerals and amino acids [12]. Vermiwash is abundant in hormones, vitamins, enzymes, micronutrients, and macronutrients and when used, aids in the effective growth of the plant [13]. According to [14], vermiwash demonstrated growth-promoting effects on morphological characteristic including root length, wet and dry weight of the shoot and root, number of leaves, leaf surface area, internode length and diameter, and plant height.

The present study aims to examine the influence of planting date, boron, vermiwash and their combined on the vegetative growth, nutrient contents and yield of cauliflower.

Martials And Methods

The experiment was carried out during growing season 2024-2025, in the plastic house (500 m^2) at the Agricultural Research Directorate Malta Dohuk, to investigate the effect of planting date, boron and vermiwash application on growth and yield of cauliflower.

The experiment included three factors, the first was two planting date (15th August and 1st September), the second factors was three levels of boron (0, 40 and 80 mg L^{-1}) the third factor was three levels of vermiwash (0, 6 and 12ml L^{-1}). After he land preparation, it was softened, then it was divided into lines and given a drip watering system before the planting of the seedlings.

After one month from sowing seeds, they were transferred to the plastic house with a 40 cm plant-to-plant spacing and 75 cm lines spacing on 15th September and 1st October. Boron and vermiwash were foliar application applied three time with in fifteen days intervales, starting after 20 days from transplanting. Each experimental unit received the other management practices similarly used by local farmers. In a factorial experiment, the treatments were set up using a Randomized Complete Bloke Design (RCBD). Consequently, this trial involved 18 treatments (2*3*3=18) with three replications each unit containing 12 plants. The results were significantly analyzed utilizing the Duncan test at the 5 % level to confirm the variations observed in the treatment means that were observed [15].

Experimental Measurements Were As Follows:

1-Vegetative characteristics

a- Plant height (cm)

b- Leaf area (cm^2)

2-mineral nutrients

a- Leaves nitrogen percentage

b- Leaves phosphorous percentage

c- Leaves potassium percentage

3-yield characteristics

a- Average fresh weight of curd (kg $plant^{-1}$)

b- Total yield (kg $unit^{-1}$).

Results

1-plant height (cm)

Data in table (1) observed that the planting date at 1st Sept. gave the heist plant height (78.00 cm) compared with 15th Aug. (75.14 cm). Foliar spraying of boron at both concentrations significantly increased plant height as compared with untreated plant, the highest value (80.58 cm) was found at concentration 80 mg L^{-1} the application of vermiwash via foliar spraying also greatly enhanced plant height (78.05 cm) was noted at 12 ml L^{-1} of vermiwash

The interaction of different planting date and boron was shown to be effect, the most favorable interaction occurred between the 1st Sept. planting date and 80 mg L^{-1} boron resulting in a plant height (82.11 cm). Regarding the combined between planting date and vermiwash, the highest plant height (79.69 cm) was observed when the 1st Sept. planting date was combined with a 12 ml L^{-1} of vermiwash. Notably, the combination of the 80 mg L^{-1} of boron and 12 ml L^{-1} of vermiwash resulted in a significantly highest plant height (83.28 cm).

The combination of planting date, boron and vermiwash had a notable impact, with the highest plant height of (84.80 cm) obtained in the combination involving the 1st Sept. planting date, 80 mg L^{-1} boron and 12 ml L^{-1} vermiwash.

Table (1) Effect of planting date, boron, vermiwash and their interaction on plant height (cm) of cauliflower plant.

Planting date	Boron (mg L^{-1})	Vermiwash (ml L^{-1})			Planting date*Boron	Planting date
		0	6	12		
15th August	0	69.80 e	68.13 e	69.70 e	69.21 c	75.14 b

	40	74.72 b-e	79.00 a-c	77.75 a-d	77.16 b	
	80	77.92 a-d	77.45 b-d	81.75 ab	79.04 ab	
1st September	0	69.83 e	71.17 de	73.65 c-e	71.55 c	78.00 a
	40	79.37 a-c	81.03 ab	80.63 a-c	80.34 ab	
	80	80.40 a-c	81.13 ab	84.80 a	82.11 a	
Planting date* Vermiwash	15th Aug.	74.15 b	74.86 b	76.40 ab	Boron	
	1st Sept.	76.53 ab	77.78 ab	79.69 a		
Boron* Vermiwash	0	69.82 c	69.65 c	71.68 c	70.38 b	
	40	77.04 b	80.02 ab	79.19 ab	78.75 a	
	80	79.16 ab	79.29 ab	83.28 a	80.58 a	
Vermiwash		75.34 b	76.32 ab	78.05 a		

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

2-leaf area (cm^2)

Table (2) showed that there were no significant effects between two planting date on leaf area. Foliar application of boron at both concentrations 40 and 80 ml L^{-1} significantly enhanced leaf area (523.07 and 545.07 cm^2) respectively. Using vermiwash had no significant effect on leaf area.

The interaction between 1st Sept. planting date and 80 mg L^{-1} boron had a highest significant value (589.28 cm^2). The combination of planting date and vermiwash had no a significant difference. Furthermore, the highest leaf area (586.00 cm^2) was found when using 80 mg L^{-1} of boron with 12 ml L^{-1} of vermiwash.

Considering the combination of planting date, boron and vermiwash, the interaction among 1st Sept. planting date, 80 mg L^{-1} boron and 12 ml L^{-1} vermiwash gave the maximum leaf area (611.50 cm^2).

Table (2) Effect of planting date, boron, vermiwash and their interaction on leaf area cm^2 of cauliflower plant.

Planting date	Boron (mg L^{-1})	Vermiwash (ml L^{-1})			Planting date*Boron	Planting date
		0	6	12		
15th August	0	458.15 c-e	415.46 d-f	462.98 c-e	445.53 c	489.03 a
	40	520.40 a-c	540.74 a-c	500.97 b-d	520.70 b	
	80	465.09 c-e	476.99 b-e	560.49 ab	500.86 b	
1st September	0	402.94 ef	345.51 f	385.75 ef	378.07 d	497.98 a
	40	519.60 a-c	535.89 a-c	524.27 a-c	526.59 b	
	80	603.62 a	552.71 a-c	611.50 a	589.28 a	
Planting date* Vermiwash	15th Aug.	481.21 a	477.73 a	508.15 a	Boron	
	1st Sept.	508.72 a	478.04 a	507.17 a		
Boron* Vermiwash	0	430.55 c	380.49 c	424.37 c	411.80 b	
	40	520.00 b	538.32 ab	512.62 b	523.65 a	
	80	534.36 ab	514.85 b	586.00 a	545.07 a	
Vermiwash		494.97 a	477.89 a	507.66 a		

Mean within a column, row and their interaction following with the same letters are not significantly significantly different according to Duncan multiple range test at 0.05 level.

3-Leaves nitrogen percentage (%)

Table (3) found that there was no significant effect between two planting date on nitrogen percentage. Spraying boron significantly enhanced nitrogen percentage, the maximum value (2.46%) was at 40 mg L^{-1} boron. Spraying vermiwash had no significant impact on nitrogen percentage.

The combined effect of planting date and boron observed a significant impact on nitrogen, the combination between 15th Aug. planting date with 80 mg L^{-1} of boron resulted in the highest value (2.55%). For the interaction between the planting date and vermiwash had no significant impact on nitrogen percentage. The maximum nitrogen percentage (2.62%) was showed between 80 mg L^{-1} boron and 12 ml L^{-1} vermiwash.

The interaction among (planting date, boron and vermiwash), significantly affected nitrogen percentage in leaves. The highest value (2.78%) was obtained as a result of interaction among 15th Aug. planting date, 80 mg L^{-1} boron and 12 ml L^{-1} vermiwash.

Table (3) Effect of planting date, boron, vermiwash and their interaction on leaves nitrogen% of cauliflower plant.

Planting date	Boron (mg L^{-1})	Vermiwash (ml L^{-1})			Planting date*Boron	Planting date
		0	6	12		
15th August	0	2.10 b	2.10 b	2.25 ab	2.15 b	2.41 a
	40	2.59 ab	2.50 ab	2.47 ab	2.52 a	
	80	2.45 ab	2.42 ab	2.78 a	2.55 a	
1st September	0	2.28 ab	2.38 ab	2.30 ab	2.32 ab	2.34 a
	40	2.31 ab	2.56 ab	2.34 ab	2.40 ab	
	80	2.10 b	2.35 ab	2.45 ab	2.30 ab	
Planting date* Vermiwash	15th Aug.	2.38 a	2.34 a	2.50 a	Boron	
	1st Sept.	2.23 a	2.43 a	2.36 a		
Boron* Vermiwash	0	2.19 b	2.24 b	2.28 ab	2.24 b	
	40	2.45 ab	2.53 ab	2.40 ab	2.46 a	
	80	2.27 ab	2.38 ab	2.62 a	2.42 a	
Vermiwash		2.31 a	2.38 a	2.43 a		

Mean within a column, row and their interaction following with the same letters are not significantly different according to Duncan multiple range test at 0.05 level.

4-Leaves phosphorous percentage (%)

It's clear from table (4) that the planting date had no significant effect on phosphorous percentage. Foliar application of boron at 40 mg L^{-1} significantly increased phosphorous percentage, which was (0.426 and 0.420%) respectively as compared with control (0.371%). Also, application of vermiwash significantly enhanced phosphorous percentage, the highest value (0.421%) was observed at 12 ml L^{-1} of vermiwash.

The combination of 1st Sept. planting date and 40 ml L^{-1} boron observed the highest phosphorous percentage (0.433%). When considering the interaction between (1st Sept. planting date and 12 ml L^{-1} vermiwash was the most influential resulted highest phosphorous percentage (0.437%). The interaction between 40 ml L^{-1} boron with 12 ml L^{-1} vermiwash showed the highest percentage (0.467%).

The interaction among planting date, boron and vermiwash significantly enhanced leaves phosphorous percentage, with the maximum percentage (0.490%) was shown from the combinate among 1st Sept. planting date, 40 ml L^{-1} boron and 12 ml L^{-1} vermiwash. While the minimum percentage (0.333%) was shown from the combined among 15th Aug. planting date, 0 ml L^{-1} boron and 0 ml L^{-1} vermiwash.

Table (4) Effect of planting date, boron, vermiwash and their interaction on leaves phosphorous% of cauliflower plant.

Planting date	Boron (mg L^{-1})	Vermiwash (ml L^{-1})			Planting date*Boron	Planting date
		0	6	12		
15th August	0	0.333 d	0.387 b-d	0.347 cd	0.356 b	0.398 a
	40	0.370 b-d	0.442 a-c	0.445 ab	0.419a	
	80	0.406 a-d	0.435 a-c	0.420 a-d	0.420 a	
1st September	0	0.364 b-d	0.370 b-d	0.424 a-d	0.386 ab	0.413 a
	40	0.378 b-d	0.431 a-c	0.490 a	0.433 a	
	80	0.428 a-c	0.433 a-c	0.397 a-d	0.419 a	
Planting date* Vermiwash	15th Aug.	0.370 b	0.422 a	0.404 ab	Boron	
	1st Sept.	0.390 ab	0.411 ab	0.437 a		
Boron* Vermiwash	0	0.349 c	0.379 bc	0.386 bc	0.371 b	
	40	0.374 bc	0.437 ab	0.467 a	0.426 a	
	80	0.417 ab	0.434 ab	0.408 a-c	0.420 a	
Vermiwash		0.380 b	0.416 a	0.421 a		

Mean within a column, row and their interaction following with the same letters are not significantly significantly different according to Duncan multiple range test at 0.05 level.

5-Leaves potassium percentage (%)

Table (5) shows that the planting date at 1st Sept. gave the highest significant percentage of potassium (1.30%). The foliar application of 80 ml L^{-1} boron was significant effect, which gave (1.30%). The highest potassium percentage was significantly affected by foliar application of vermiwash at concentration 6 ml L^{-1}.

The same table shows that the duale interaction was significant effect, the interaction of 1st Sept. planting date with 80 ml L^{-1} boron had a higher percentage (1.32%). The interaction between 15th Sept. planting date and 6 ml L^{-1} vermiwash had a highest leaves potassium percentage (1.32%). The highest value (1.32%) was shown between 80 ml L^{-1} boron and 6 ml L^{-1} vermiwash.

Moreover, the three factors planting date, boron and vermiwash interacted to produce a substantial impact, the combination of (1st Sept. planting date, 80 ml L^{-1} boron and 6 ml L^{-1} vermiwash) gave the maximum leaves potassium percentage (1.34%).

Table (5) Effect of planting date, boron, vermiwash and their interaction on leaves potassium% of cauliflower plant

Planting date	Boron (mg L^{-1})	Vermiwash (ml L^{-1})			Planting date*Boron	Planting date
		0	6	12		
15th August	0	1.18 b	1.22 ab	1.25 ab	1.21 b	1.25 b
	40	1.23 ab	1.29 ab	1.30 ab	1.27 ab	
	80	1.24 ab	1.30 ab	1.29 ab	1.28 ab	
1st September	0	1.18 b	1.33 a	1.31 ab	1.27 ab	1.30 a
	40	1.30 ab	1.31 ab	1.31 ab	1.31 a	
	80	1.32 ab	1.34 a	1.29 ab	1.32 a	
	15th Aug.	1.22 b	1.27 ab	1.28 ab		

Planting date* Vermiwash	1st Sept.	1.26 ab	1.32 a	1.30 a	Boron
Boron* Vermiwash	0	1.18 b	1.27 a	1.28 a	1.24 b
	40	1.27 a	1.30 a	1.31 a	1.29 ab
	80	1.28 a	1.32 a	1.29 a	1.30 a
Vermiwash		1.24 b	1.30 a	1.29 a	

Mean within a column, row and their interaction following with the same letters are not significantly significantly different according to Duncan multiple range test at 0.05 level.

6-Average fresh weight of curd (kg plant^{-1})

Table (6) displays that there were no significant differences between planting date in terms of average fresh weight of curds. The maximum value of on average fresh weight of curds was obtained with 80 ml L^{-1} boron which was (3.39 kg plant^{-1}). The data reveals that the spraying 12 ml L^{-1} vermiwash significantly enhanced on average fresh weight of curds (kg plant^{-1}) which gave the maximum value (3.14 kg plant^{-1}).

Concerning the interaction between planting date and boron was significantly effective, the interaction between 1st Sept. planting date and 80 ml L^{-1}boron was the most influential treatment and have the highest value (3.43 kg plant^{-1}). The interaction of 1st Sept. planting date with 12 ml L^{-1} vermiwash appeared to be the most operative interaction as it gave the highest value (3.19 kg plant^{-1}). The combined of boron with vermiwash had a significant impact on average fresh weight of curds, the maximum value (3.85 kg plant^{-1}) was observed between 80 ml L^{-1} boron and 12 ml L^{-1} vermiwash.

The interaction among planting date, boron and vermiwash significantly affected on average fresh weight of curds, the maximum value (3.90 kg plant^{-1}) was observed as a result of the interaction among 1st Sept. planting date, 80 ml L^{-1} boron and 12 ml L^{-1} vermiwash, whereas the minimum vale (1.98 kg plant^{-1}) was observed from the interaction among 1st Aug. planting date, 0 ml L^{-1} boron and 0 ml L^{-1} vermiwash.

Table (6) Effect of planting date, boron, vermiwash and their interaction on average fresh weight of curds (kg plant-1) of cauliflower plant.

Planting date	Boron (mg L^{-1})	Vermiwash (ml L^{-1})			Planting date*Boron	Planting date
		0	6	12		
15th August	0	1.98 g	2.15 g	2.21 g	2.12 c	2.87 a
	40	2.78 ef	3.34 b-d	3.29 cd	3.14 b	
	80	3.00 c-e	3.30 cd	3.79 ab	3.36 ab	
1st September	0	2.21 g	2.26 g	2.42 fg	2.30 c	2.98 a
	40	2.93 de	3.47 a-c	3.23 c-e	3.21 ab	
	80	3.02 c-e	3.34 b-d	3.91 a	3.43 a	
Planting date* Vermiwash	15th Aug.	2.59 c	2.93 ab	3.10 a	Boron	
	1st Sept.	2.72 bc	3.03 a	3.19 a		
Boron* Vermiwash	0	2.09 e	2.21 e	2.32 e	2.21 c	
	40	2.85 d	3.41 b	3.26 bc	3.17 b	
	80	3.01 d	3.32 bc	3.85 a	3.39 a	
Vermiwash		2.65 b	2.98 a	3.14 a		

Mean within a column, row and their interaction following with the same letters are not significantly significantly different according to Duncan multiple range test at 0.05 level.

7-Total yield (kg unit^{-1})

Table (7) observed that there were no significant impact between planting date on total yield. Foliar spraying of boron at level 80 mg L^{-1} had the maximum significant value (40.74 kg unit^{-1}) compared to other treatments. Using 12 ml L^{-1} vermiwash had the maximum significant value (37.73 kg unit^{-1})

The interaction between two factors was significant effect, the combination between 1st Sept. planting date and 80 mg L^{-1} boron produced the maximum total yield (41.11 kg unit^{-1}). For the effect between planting date and vermiwash, the best interaction (38.26 kg unit-1) was showed between 1st Sept. planting date and 12 ml L^{-1} vermiwash. The highest value (46.25 kg unit^{-1}) was obtained between 80 mg L^{-1} boron and 12 ml L^{-1} vermiwash.

The best interaction among three factors was found among 1st Sept. planting date, 80 mg L-1 boron and 12 ml L^{-1} vermiwash which gave (46.97 kg unit^{-1}). While the lowest value (23.76 kg unit-1) was found among 15th Aug. planting date, 0 mg L^{-1} boron and 0 ml L^{-1} vermiwash.

Table (7) Effect of planting date, boron, vermiwash and their interaction on total yield (kg unit-1) of cauliflower plant.

Planting date	Boron (mg L^{-1})	Vermiwash (ml L^{-1})			Planting date*Boron	Planting date
		0	6	12		
15th August	0	23.76 g	25.84 g	26.54 g	25.38 c	34.47 a
	40	33.40 ef	40.06 b-d	39.50 cd	37.65 b	
	80	36.01 c-e	39.54 cd	45.53 ab	40.36 ab	
1st September	0	26.50 g	27.17 g	29.05 fg	27.57 c	35.73 a
	40	35.10 de	41.68 a-c	38.76 c-e	38.51 ab	
	80	36.30 c-e	40.07 b-d	46.97 a	41.11 a	
Planting date* Vermiwash	15th Aug.	31.06 c	35.15 ab	37.19 a	Boron	
	1st Sept.	32.63 bc	36.31 a	38.26 a		
Boron* Vermiwash	0	25.13 e	26.50 e	27.80 e	26.48 c	
	40	34.25 d	40.87 b	39.13 bc	38.08 b	
	80	36.15 cd	39.81 bc	46.25 a	40.74 a	
Vermiwash		31.84 b	35.73 a	37.73 a		

Mean within a column, row and their interaction following with the same letters are not significantly significantly different according to Duncan multiple range test at 0.05 level.

Discussions

Results in tables (1 and 4) showed that the planting date significantly enhanced plant height and potassium percentage, the cauliflower plants grown on the second planting date performed well. This might be as a result of their availability to ideal environment factors, such as the ideal temperature, light levels and relative humidity for germination and growth. Numerous studies indicated that the date of planting had a significant effect on plant development and yield, and they also determined that the effect was mostly due to either soil moisture or temperature or both [16]. More metabolite assimilation may occur from improved photosynthetic conditions in plant, which have the ideal growing conditions for plant growth and development. Similar results were found in cauliflower by [17]. Established that the planting date at 1st September considerably increased plant height, leaf area, nitrogen, phosphorous, potassium, weight of curd and total yield as compared with 15th September and 1st October [5].

It was observed from the above-mentioned results in tables (1-7) that the boron significantly caused appositive effect on plant height, leaf area, N%, P%, K% and total yield. The reason behind this may be due to the boron is essential for a variety of biochemical functions, including cell division, tissue growth and the metabolism of carbohydrates and the passage of sugar across membranes in plants [18]. Or it may result from the nutrients efficient function and influence on physiological processes such as absorption of nutrients and their distribution throughout the plant, as it aids in cell division and elongation in areas of active growth in the apices of root and meristematic tissues in the vegetative parts. It also regulates the rate at

which water is absorbed by the plant and has a beneficial effect on controlling the essential activities of enzymes which increases the likelihood of plant growth [19]. In their research on broccoli, cabbage and cauliflower, found that increasing the boron dose led to favorable growth, development and yield outcomes. This suggested appositive correlation between boron administration and increased yield [20]. The finding of the current study is also supported by the findings of a study by [21] which showed the significant effect of boron on enhancing K%, P% and curd yield of broccoli. This increase in curd output with higher boron may be due to boron role in the uptake of essential plant nutrients as well as the metabolism and transport of essential macromolecules in plant [22]. Cauliflower and development depend heavily on boron. Because it plays a role in cell division, boron promotes the growth of roots and shoots. It is linked to a member of physiological functions including protein synthesis, calcium metabolism, auxin synthesis, sugar metabolism and the translocation of nitrogen and potassium [23]. Even though vegetables require minor amounts of boron, the researches results confirm that a lack of boron has a detrimental effect on plant growth and yield [24]. Found that when the boron increased, the curd yield increased linearly [25]. It was also revealed that spraying of vermiwash had a significantly enhanced vegetative and yield of cauliflower, these results correspond with [26] vermiwash is well known for its significant effects on plant growth and development, root initiation, root growth, plant development, growth rate stimulation and crop production improvement. It also boosts crop nutrient uptake, which leads to improved crop yield. According to [27] vermiwash is also enhanced with plant growth hormones that promote rapid development and high production, such as auxins, cytokinin, gibberellins, amino acids and vitamins. Vermiwash contains earthworm secretions and enzymes, which would promote crop development and yield [28]. It improved the soils physiochemical characteristics and decreased insect pest infestation, which would have allowed plants to absorb more nutrients and produced higher growth and yield. Additionally, it supports crop production that is sustainable [29]. Vermiwash spraying significantly increased the yields quality and quantity of vegetables [30]. According to the hypothesis of Gamaley et al. (2006), vermiwash applied topically enhances plant physiology, increasing product output and quality. Plant height, leaf count, and chlorophyll content all significantly increased when 10% diluted vermiwash was sprayed on the leaves [31].

Conclusions

Concluded that utilizing each boron, vermiwash and their interaction resulted in the improvement of all parameters during two planting date. Moreover, the spraying of boron and vermiwash positively affected on vegetative growth and yield parameters of cauliflower plant under plastic house.

Acknowledgment

The researchers thanked College of Agricultural Engineering Sciences and Agricultural Research Directorate for their assistance, which contributed to the completion of this research.

References

[1]. Noor F, Aktar T, Mahomud M.S .and Islam M.M. (2014) Impact of processing methods on quality of cauliflower pickle. Journal of Science and Technology 12: 48-53. DOI: 10.20546/ijcmas.2021.1001.168

[2]. Bhandari, S. R., and Kwak, J.H. (2015). Chemical composition and antioxidant activity in different tissues of Brassica vegetables.Molecules, 20(1).1228-1243

[3]. McDonald, L. (1971). Garden vegetables: the story of vegetables. Thomas Nelson Inc., New York.

[4]. Misra, A. D., Kumar, A., and Meitei, W. I. (2014). Effect of spacing and planting time on growth and yield of onion var. N-53 under Manipur Himalayas. Indian Journal of Horticulture, 71(2): 207-210.

[5]. Al-Sudani Z. A. J. and N. M. H. Al-Bayaty (2020) Effect of Planting Date and Phosphate Fertilization on Growth and Yield of Broccoli Planted in Southern Iraq. Diyala Agricultural Sciences Journal (DASJ). 12 (1): 2020.

[6]. Camacho-Cristobal, J. J., Navarro-Gochicoa, M. T., Rexach, J., Gonzalez-Fontes, A., & Herrera-Rodriguez, M. B. (2018). Plant Response to Boron Deficiency and Boron Use Efficiency in Crop Plants. *Plant Micronutrient Use Efficiency*, 109-121. New York: Academic press.

[7]. Singh, V.; Singh, A.K.; Raghuvanshi1, T.R.; Singh, M.K.; Singh, V. and Singh, U. (2017). Influence of Boron and Molybdenum on Growth, Yield and Quality of Cauliflower (*Brassica oleracea* L. var. botrytis). *Int. J. Curr. Microbiol. App. Sci*. 6(10): 3408-3414.

[8]. Shireen, F., Nawaz, M., Chen, C., Zhang, Q., Zheng, Z., Sohail, H., et al. (2018). Boron: functions and approaches to enhance its availability in plants for sustainable agriculture. *Int. J. Mol. Sci.* 19 (7), 1856. doi: 10.3390/ijms19071856

[9]. Ningawale, D. K., Singh, R., Bose, U.S., Gurjar, P. S., Sharma, A. & Gautam, U. S. (2016). Effect of boron and molybdenum on growth, yield and quality of cauliflower (*Brassica oleracea* var. *botrytis*) cv. Snowball 16. *Indian Journal of Agricultural Sciences*, *86*(6), 825-829.

[10]. Farooq, M., Bakhtiar, M., Ahmed, S., Ilyas, N., Khan, I., Saboor, A., & Khan, I. (2018). Influence of Sulfur and Boron on the growth and yield of Broccoli. *Interna-tional Journal of Agricultural and Environmental Research*, *4*(4), 9-16.

[11]. Bendalam, P., and Kaviti, V. L. 2020. Vermiwash. Just Agriculture, p. 42. Dongare, S., and Gawas, I. 2021. Use of vermiwash in the field of Agriculture. Just Agriculture, p.32.
[12]. Dongare S. and Gawas I. (2021) Use of vermiwash in the field of agriculture. Just Agriculture, p:32-36
[13]. Varghese, S.M, and Prabha, M.L. 2014. Biochemical characterization of vermiwash and its effect on growth of Capsicum frutescens. Malay Journal of Bioscience, 1(2), 86-91.
[14]. Kaur P, Bhardwaj M, Babbar I. 2015. Effect of Vermicompost and Vermiwash on Growth of Vegetables. Res J Anim Vet Fish Sci 3 (4)9-12
[15]. SAS Institute, Inc (2010). Statistical analysis system. SAS institute Inc., Cary, NC. USA.
[16]. Khalifa, F.M. (1981.) Some factors influencing the development of sunflower (*Heliansus annus* L.) under dry farming system in Sudan, *Journal of Agricultural Science Cambridge,* Vol. 57, No.1: 10-17.
[17]. Devi P, Sharma A, Saini A, Sharma S. Effect of different spacing and transplanting dates on the growth and yield of cauliflower (*Brassica oleracea var. botrytis* L.). Int J Adv Res. 2022; 10:280-8. doi: 10.21474/IJAR01/15350.
[18]. Thapa U, Das R, Mandal AR, Debanath S. Influence of GA3 and NAA on growth, yield and quality attributing characters of sprouting broccoli [Brassica oleracea (L.) var. Italica Plenk]. Crop research. 2013;46(1to3):192195.
[19]. Barker, A.V. and D.J. Pilbeam (2007). Hand book of plant Nutrition. CRC Taylor and Francis Group.
[20]. Pizetta LC, Ferreira ME, Cruz MC, Barbosa JC. (2005) Response of boron fertilization on broccoli, cauliflower and cabbage planted in sandy soil. Horticultura Brasileira. 23:51-6.
[21]. Islam M, Hoque MA, Reza MM & Chakma SP (2015) Effect of boron on yield and quality of broccoli genotypes. *International Journal of Experimental Agriculture*, **5**(1):1-7.
[22]. Ahmad W, Niaz A, Kanwal S, Rahmatullah & Rasheed M (2009) Role of boron in plant growth: A review. *Journal of Agricultural Research* 47**(**3): 329-338.
[23]. Kumar R., R.P. Singh and P. C. Chaurasia (2011) Effect of Boron on Growth and Yield of Cauliflower (Brassica oleracea var. botrytis). Journal of Plant Development Sciences Vol.3 (1 and 2): 207-21.
[24]. Yazıcı, D., & Korkmaz, K. (2020). The effect of potassium applications on toxicity and uptake of boron in buckwheat. Academic Journal of Agriculture, 9(1), 151–162.
[25]. Hassan MR, Julie SN, Akber A, Kundu PK & Zaman MS (2018) Influence of micronutrient (boron) for the growth and yield of cauliflower. *Journal of Bioscience and Agriculture Research* **18**(1): 1464-1469. DOI:10.18801/jbar.180118.181
[26]. Nayak H, Rai S, Mahto R, Rani P, Yadav S, Prasad SK and Singh RK. (2019) Vermiwash: A potential tool for sustainable agriculture, Journal of Pharmacognosy and Phytochemistry, SP5: 308-312.
[27]. Gopal, M., Gupta, A., Palaniswami, C., Dhanapal, R. and Thomas, G.V. (2010). Coconut leaf vermiwash: a bio-liquid from coconut leaf vermicompost for improving the crop production capacities. *Current Science.*, 98: 1202-1210.
[28]. Rajan M.R. and Murugesan P. (2012). Influence of Vermiwash on Germination and Growth of Cow Pea Vigna Ungiculata and Rice Oryza Sativa. IOSR Journal of Pharmacy **e**-ISSN: 2250-3013, **p**-ISSN: 2319-4219.www.iosrphr.org Vol. 2, Issue 6, Nov-Dec., PP. 31-34.
[29]. Verma, S., Babu, A., Patel, A., Singh, S.K., Pradhan, S.S., Verma, S.K. and Singh, R.K. (2018) Significance of vermiwash on crop production: A review. Journal of Pharmacognosy and Phytochemistry, 7: 297-301.
[30]. Sundararasu K (2016) Vermiwash: Effect of vermiwash on growth and yielding pattern of selected vegetable crop Chilli, Capsicum annuum, International Journal of Advanced Research in Biological Sciences, 3(9): 155-160.
[31]. Pathak, R.K. and Ram, R.A. (2004). Manual on Jaivik Krishi, Central Institute for Subtropical Horticulture, Rehmankhera, P.O. Kokari, Lucknow-227107, 24, 31-32.
[32]. Gamaley, A.V., Nadporozhskaya, M.A., Popov, A.I., Chertov, O.G., Kovsh, N.V. and Gramova, O.A. (2006). Non-root nutritional with vermicompost extract as the way of ecological optimization, Plant nutrition-food security and susceptibility of argo-ecosystem, 862-863.

تاثير مواعيد الزراعة ورش البورون والسماد السائل على النمو الخضري والعناصر المعدنية والحاصل لنبات القرنبيط (*Brassica oleracea var. botrytis L.*)

مريم عبدالرحمن مصطفى[1] غربت حسن محمد[1]

[1]قسم البستنة، كليه علوم الهندسة الزراعية، جامعة دهوك، اقليم كردستان، العراق.

الخلاصة

أجريت هذه الدراسة خلال موسم النمو 2024-2025 في البيت البلاستيكي (500 م2) بمديرية البحوث الزراعية، لدراسة تأثير موعدين للزراعة (15 اب و1ايلول) وثلاثة مستويات من البورون (0 و40 و80 ملغم لتر-1) وثلاثة مستويات من السماد السائل (0 و6 و12 مل لتر-1) على النمو الخضري (ارتفاع النبات والمساحة الورقية) والعناصر المعدنية (نسبة المؤية للنايتروجين والفسفور والبوتاسيوم) و الحاصل (متوسط الوزن الطري والحاصل الكلي) لنبات القرنبيط. صممت التجربة في تجربة عاملية حسب (***RCBD***) أظهرت النتائج أن 1 ايلول عزز بشكل كبير ارتفاع النبات (سم) ، ونسبة المؤية للبوتاسيوم في الاوراق. أدى الرش الورقي 40 و 80 مغم لتر-1 من البورون إلى تعزيز ارتفاع النبات (سم) ، والمساحة الوراقية (سم 2) ، ونسبة المؤية للنايتروجين ، والفوسفور ، والبوتاسيوم ، ومتوسط الوزن الطري للراس (كجم نبات -1) والحاصل الكلي (كغم وحدة -1). وبالمثل ، أظهر السماد السائل تأثيرات إيجابية ومعنوية على جميع الصفات المدروسة باستثناء المساحة الوراقية (سم2) ونسبة المؤية للنايتروجين. كان للتداخلات الثانوية، مواعيد الزراعية والبورون، مواعيد الزراعية والسماد السائل، البورون والسماد السائل تأثيرات معنوية على جميع صفات النمو الخضري والحاصل. والجدير بالذكر أن التداخل الثلاثي بين 1 ايلول ، 80 ملغم لتر-1 من البورون و 12 مل لتر -1 من السماد السائل اعطت اعلى قيمة معنوية لكل من ارتفاع النبات (سم) ، والمساحة الورقية (سم 2) ، ومتوسط الوزن الطري للراس (كغم نبات -1) الحاصل الكلي (كغم وحدة -1).

الكلمات المفتاحية: العائلة الصليبية، العناصر الغذائية، الاسمدة العضوية، البورون والقرنبيط.