

Enhancing the Chemical Content of Broccoli *Brassica oleracea* var. *Italica* through the Use of Organic Fertilizers and Nutrient Sprays.

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Abstract

The study was conducted in Al-Bu'itha research station -College of Agriculture - University of Anbar, during the growing season 2022-2023 to find out the effect of poultry manure at levels (0, 100, 200 and 400 g plant⁻¹) and spraying with Foliar nutrients at concentrations (0, 2, 4 and 6 ml L⁻¹) on the growth and yield of broccoli. A factorial experiment was carried out according to the Randomized Complete Block Design (RCBD) with three replications. The results showed that there were significant differences when added organic fertilization, as the treatment was superior to 400 g plant⁻¹ in the percentage of dry matter in crude 13.67%, the content of crude vitamin C 139.50 mg g⁻¹, the percentage of nitrogen in crude 2.58%, phosphorus is 3.26% and potassium is 0.187%. As for the foliar spraying with nutrient solution, the spraying treatment with a concentration of 6 ml L⁻¹ was superior in the percentage of dry matter in flower head 11.29%, the content of crude Vitamin C 127.13 mg g⁻¹, the percentage of nitrogen in crude 2.27%, phosphorus 2.61% and potassium 0.153%. As for the interaction between the factors of the study, the treatment of adding organic fertilizer at a concentration of 400 g plant⁻¹ with spraying with a nutrient solution at a concentration of 6 ml L⁻¹ had a significant superiority in all studied traits .

Keywords: Broccoli , Organic Fertilizer, Nutrient spray

Introduction

Broccoli, *Brassica oleracea* var. *italica*, which belongs to the Brassicaceae family and is considered an important winter vegetable crop in many countries of the world. It is a herbaceous plant morphologically similar to cauliflower [11,19]. It is a rich source of antioxidants and vitamins such as vitamin B1, C, and E, and is also rich in vitamin A, B2, and K [2]. Each 10g of florets in broccoli contains 89.1g of water, 32 calories, 3.6 protein, 0.3g of fat, 5.9g of carbohydrates. It also contains nutrients such as iron, calcium, zinc, sulfur, potassium and selenium [20]. and also contains beta-carotene. Its leaves are also a source of polyphenols, fats and fiber [8]. The broccoli plant has dense vegetative growth, so it needs balanced amounts of micronutrients to increase production and improve its quality. Organic fertilization also works to improve

soil composition and the availability of nutrients in the soil. Studies have shown that adding poultry waste to the soil significantly affected the values of the weighted diameter average. For soil aggregates by reducing C/N ratio through the decomposition of poultry waste quickly and in the presence of calcium ions and the formation of calcium humate, which has a high effect in binding the particles together, as well as works to increase the permeability of the soil and its ability to hold water due to the organic matter having a surface area and low bulk density have, and then reduce the state of soil erosion [3,17]. Some nutrients are difficult to transmit through the root system due to the presence of many factors related to the environment surrounding the root or to the nutrients themselves, and this leads to their unreadiness

for absorption by the plant. vegetative, and that uptake through the root requires more time due to the uptake determinants of unsuitable soil conditions, whether high carbon content or alkaline soil, or due to high salinity [9]. due to the lack of studies on the

Materials

The field experiment was carried out in the fields of the College of Agriculture - University of Anbar in the city of Ramadi, the centre of Anbar Governorate, located at latitude 33.28° and longitude 43.21° in the fall season 2022-2023 for the period from 15/8/2022 - to 30/1/2023. The soil was prepared by conducting the plowing process twice, orthogonally, by the overturning plow, smoothing it by the harrow plow, and then levelling it. The seeds were sown in a cork container in a private nursery on 8/15/2022, and the seedlings were transferred to the field on 1/10/2022. The single hybrid of broccoli (Jasmine) was used, which is one of the locally approved varieties. Two factors were used in this study, the first factor was Organic fertilization with four levels (0, 100, 200 and 400 g Plant⁻¹), which were coded F0, F1, F2 and F3 in respectively, and the second factor was spraying with Foliar nutrients (Synergiac AA) at concentrations (0, 2, 4 and 6 ml L⁻¹) which are denoted by the symbols S0, S1, S2 and S3 in respectively, The Spray solution contains Amino Acid, Seaweed extract, Macro and Microelement (N, P, K, B, Cu, Zn and Mn), The process of spraying the nutrient was repeated five times, between one spray and another 15 days apart, and the first spray was on 15/10/2022. It was implemented as a factorial experiment with a randomized complete block design (RBCD) with three replications (4 x 4), where the field was divided into terraces 4 m long, 0.75 m wide,

broccoli crop in Iraq, this research was carried out, which aims to study the effect of organic fertilizers and foliar feeding with Synergiac AA solution on the growth and yield of broccoli. In the absence of studies on the newly spread broccoli crop in Iraq.

and

Methods

and a planting distance of 0.4 m between one plant to another, with 10 plants per terrace, as the terrace represents an experimental unit for each treatment, and accordingly the experiment included 48 treatments, with 16 treatments for each repeater. Neutral fertilizer NPK (20,20,20) was added at an amount of 230 Kg ha⁻¹ in three batches, 50% of which was when the seedlings were transferred to the field, 25% after 20 days of the first batch, and 25% after 20 days of the second batch, according to what was stated in it. [10]. The results of the data were analyzed using the GenStat statistical analysis program, and the averages were compared according to the least significant difference (LSD) test at the level of 0.05 [4.]

2.1 Characters of the study:

2.1.1percentage of dry matter in crud (%):It was measured according to the following equation:

Dry matter ratio = (dry weight/wet weight) x 100

2.1.2crud content of Vitamin C (Mg 100 g⁻¹fresh weight): Vitamin C was estimated according to the method described by [14.]

2.1.3percentage of nitrogen in crud (%):According to the method described by [13.]

2.1.4percentage of phosphorus in crud (%):It was estimated according to the method [18.]

2.1.5percentage of potassium in crud (%):According to the method [12.]

Results

and

Discussion

3.1percentage of dry matter in crud(%)

The results of the statistical analysis in Table (1) showed that there were significant differences between the treatments sprayed with the nutrient solution, as the treatment S3 (6 ml L⁻¹) recorded the highest rate of 11.29%, while the comparison treatment S0 recorded the lowest rate of 9.98%.

As for the addition of organic fertilizer, there were significant differences between the treatments, as the F3 treatment (400g plant⁻¹)

recorded the highest rate of 13.67%, while the comparison treatment recorded the lowest rate of 7.63%.

As for the interaction between the treatments of spraying with the nutrient solution and the addition of organic fertilizer, there were significant differences, as the treatment S3F3 (6 ml l⁻¹ + 400 g plant⁻¹) recorded the highest rate of 14.76%, while the comparison treatment S0F0 recorded the lowest rate of 7.01%.

Table 1. Effect of organic fertilizers and spraying with nutrient solutions and the interaction between them in the percentage of dry matter in crud.(%)

Treatments Spraying (S)	Organic fertilizer (F)				Mean (S)
	F ₀	F ₁	F ₂	F ₃	
S0	7.01	9.57	10.69	12.56	9.98
S1	7.04	10.01	11.04	13.52	10.40
S2	8.14	10.16	11.52	13.74	10.89
S3	8.32	10.45	11.63	14.76	11.29
Mean (F)	7.63	10.05	11.22	13.67	
LSD _{0.05} F= 0.12		LSD _{0.05} S= 0.12		LSD _{0.05} F×S= 0.24	

3.2crud content of Vitamin C (Mg 100 g-1fresh weight(

The results show in Table (2) that the foliar spraying with the nutrient solution had a significant effect, as treatment S3 recorded the highest rate of 127.13 mg 100 g⁻¹ fresh weight, while control treatment S0 recorded the lowest rate of 117.63 mg 100 g⁻¹ fresh weight.

As for the addition of organic fertilizer, there were significant differences, as the treatment

F3 recorded the highest rate of 139.50 mg 100 g⁻¹ fresh weight, while the comparison treatment F0 recorded the lowest rate of 103.63 mg 100 g⁻¹ fresh weight.

As for the interaction between the study factors, there were significant differences between the treatments, as the treatment S3F3 recorded the highest rate of 144.05 mg 100 g⁻¹ fresh weight, while the comparison treatment S0F0 recorded the lowest rate of 96.00 mg 100 g⁻¹ fresh weight

Table 2. Effect of organic fertilizers and spraying with nutrient solutions and the interaction between them in crud content of vitamin C (mg 100 g-1 fresh weight.)

Treatments Spraying (S)	Organic fertilizer (F)				Mean (S)
	F ₀	F ₁	F ₂	F ₃	
S0	96.00	114.00	123.50	137.00	117.63
S1	102.50	114.00	126.50	137.50	120.13
S2	106.50	118.00	131.50	139.00	123.75
S3	109.50	121.00	133.50	144.50	127.13
Mean (F)	103.63	116.75	128.75	139.50	
LSD _{0.05} F= 0.93		LSD _{0.05} S=0.93		LSD _{0.05} F×S= 1.86	

3.3percentage of nitrogen in crud(%)

The results of the statistical analysis in Table (3) indicate that there are significant differences in foliar spraying, as treatment S3 recorded a rate of 2.27%, while treatment S1 recorded the lowest rate of 1.90%.

As for the addition of organic fertilizer, it had a positive effect, as treatment F3 recorded the

highest rate of 2.58%, while comparison treatment F0 recorded the lowest rate of 1.68%.

As for the interaction between the study factors, there was a positive effect, as treatment F3S3 recorded the highest rate of 2.76%, while treatment F0S1 and F0S0 recorded the lowest rate of 1.57 and 1.58%.

Table 3. Effect of organic fertilizers and spraying with nutrient solutions and the interaction between them in Percentage of Nitrogen in crud.(%)

Treatments Spraying (S)	Organic fertilizer (F)				Mean (S)
	F ₀	F ₁	F ₂	F ₃	
S0	1.58	1.82	2.65	2.49	2.13
S1	1.57	1.88	1.64	2.51	1.90
S2	1.78	1.90	2.26	2.58	2.13
S3	1.80	2.16	2.38	2.76	2.27
Mean (F)	1.68	1.94	2.23	2.58	
LSD _{0.05} F= 0.14		LSD _{0.05} S= 0.14		LSD _{0.05} F×S= 0.28	

3.4percentage of phosphorus in crud:(%)

The results of Table (4) when spraying the nutrient solution show that there are significant differences between the treatments, as treatment S3 recorded the highest rate of 2.61%, while the comparison treatment S0 recorded the lowest rate of 2.28%.

As for the addition of organic fertilizer, there were significant differences, as treatment F3

recorded the highest rate of 3.26%, while comparison treatment F0 recorded the lowest rate of 1.68%.

It also showed an overlap between spraying with nutrient solution and adding organic fertilizer. There were significant differences, as the treatment F3S3 recorded the highest rate of 3.40%, while the control treatment F0S0 recorded the lowest rate of 1.35%.

Table 4. Effect of organic fertilizers and spraying with nutrient solutions and the interaction between them in Percentage of Phosphorus in crud.(%)

Treatments Spraying (S)	Organic fertilizer (F)				Mean (S)
	F ₀	F ₁	F ₂	F ₃	
S0	1.35	2.05	2.55	3.15	2.28
S1	1.65	2.10	2.70	3.20	2.41
S2	1.80	2.10	2.80	3.30	2.50
S3	1.90	2.35	2.80	3.40	2.61
Mean (F)	1.68	2.15	2.71	3.26	
LSD _{0.05} F= 0.02		LSD _{0.05} S= 0.02		LSD _{0.05} F×S= 0.05	

3.5percentage of Potassium in crud:(%)

The results of Table (5) show that spraying with a nutrient solution had a significant superiority, as the treatment S3 recorded the highest rate of 0.153, while the comparison treatment S0 recorded the lowest rate of 0.137%.

As for the addition of organic fertilizer, there were significant differences, as the treatment

F3 recorded the highest rate of 0.187%, while the comparison treatment F0 recorded the lowest rate of 0.114%.

As for the interaction between the study factors, there were significant differences between the treatments, as the treatment S3F3 recorded the highest rate of 0.200%, while the comparison treatment S0F0 recorded the lowest rate of 0.105%.

Table 5. Effect of organic fertilizers and spraying with nutrient solutions and the interaction between them in Percentage of Potassium in crud.(%)

Treatments Spraying (S)	Organic fertilizer (F)				Mean (S)
	F ₀	F ₁	F ₂	F ₃	
S0	0.105	0.130	0.140	0.173	0.137
S1	0.110	0.130	0.145	0.180	0.141
S2	0.120	0.130	0.150	0.194	0.148
S3	0.120	0.130	0.160	0.200	0.153
Mean (F)	0.114	0.130	0.149	0.187	
LSD _{0.05} F= 0.002		LSD _{0.05} S= 0.002		LSD _{0.05} F×S= 0.003	

It is noted from the results of tables (1, 2, 3, 4 and 5) that the increase in the chemical content of the flowering tablets when foliar spraying with the nutrient solution and the addition of organic fertilizer may be due to the role of the nutrient solution and what it contains of macro and micro nutrients, seaweed extract and organic acids In a form that can be absorbed by the leaves, it is of great importance in improving the growth of plants through the arrival of the elements faster than if they were added to the soil, as they may be subject to sedimentation, leaching

and fixation processes, especially in the basic soils prevailing in Iraq [1]. Therefore, the increase in the concentrations of the above elements may be due to their absorption directly through the stomata and through the cuticle [16]. It enters the plant tissue directly, and this contributes to increasing the vital activities, which leads to an increase in its absorption with the rest of the other elements to establish a state of nutritional balance [7]. The reason may be due to the role of organic fertilizers that provide humic acid, which has a fundamental role in increasing the permeability of cell membranes, which

facilitates the process of transfer of nutrients and thus increases the efficiency of plant growth [6]. In addition, it works to reduce the soil pH, so that the nutrients are available for absorption by the plant, such as nitrogen,

phosphorus, and potassium, and their transfer and accumulation in the flowering tablets [15], and this is consistent with what [5] found when using organic fertilization and foliar spraying on broccoli.

Conclusion

The foliar spraying of the nutrient solution, which contains a group of macro and micro nutrients at a concentration of 6 ml L⁻¹, and the addition of organic fertilizer (poultry manure) at a level of 400 g Plant⁻¹, had a significant effect, whether the factors were

singular or combined with each other, in increasing the characteristics of the content. The chemistry of the crudes and thus an improvement leads to an increase in the quality yield..

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