



ORIGINAL ARTICLE

EFFECT OF FOLIAR APPLICATION OF MICRONATE 15 ON THE GROWTH AND YIELD OF TWO BROCCOLI CULTIVARS (*BRASSICA OLERACEA*) VAR. ITALIC

Heba A. Hussein^{1,*}, Husham M. Hishem¹ and Hakeem Sh. Atallah²

¹Department of Plant Production, Al-Mussaib Technical College, Al-Furat Al-Awsat Technical University, Iraq.

²Directorate of Agriculture in Babil, Ministry of Agriculture, Iraq.

E-mail: com.hba88@atu.edu.iq

Abstract: The experiment was conducted during the agricultural season 2020-2021 in a field in Al-Azzawiya district in Babylon province. The research aims to find out the effect of foliar spraying of four concentrations of Micronate 15 nutrient solution, namely 0, 1, 2 and 3g.L⁻¹ water, on the growth and yield of two hybrids of broccoli Polo and Jassmine. The experiment was applied according to the Randomized complete block design (RCBD) with three replicates. The results showed the significantly excelled of the Polo cultivar on the Jassmine cultivar in trait of plant height 62.58cm and the 37.33 number of leaves. The dry weight of vegetative was 247.7g. The results also showed the significantly excelled of the Jassmine cultivar in the average diameter of the main flowering head (22.42)cm and the weight of the main flowering disc (535.9)g and the number of side discs (6.24) head.plant⁻¹ and the total yield of the plant was (811.2) g.plant⁻¹. All treatments of foliar spray showed significantly excelled in average vegetative growth characteristics and yield compared to the control treatment. The results of the interaction showed the significant superiority of the Polo cultivar at a concentration of 3gm.L⁻¹ water in average plant height (71.00)cm, number of leaves (46.33) leaves and dry weight of shoots (265.0)g. While, the Jassmine cultivar was significantly excelled at a concentration of 3gm.L⁻¹ water in the average diameter of the main flowering disc (25.67)cm, the weight of the main flowering disc (644.0)g, and the number of lateral discs (6.60) heads.plant⁻¹ and the total yield of the plant (963.7)g.plant⁻¹.

Key words: Broccoli, Cruciferous, Foliar nutrition, Nutrient solution.

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1. Introduction

Brassica oleracea var. *italica* belongs to the cruciferous family, to which many winter vegetable crops belong, such as cauliflower and cauliflower, in addition to other crops. It is considered one of the richest crops of the Crusader family in terms of nutritional value and is widely used medicinally in many countries of the world. It contains vitamins A, B1, B2, B5, B6 and E, as well as calcium, iron, zinc, manganese and carotene, which is converted into vitamin A [Hamza and AL-Taey (2020), Mariush and AL-Mharib (2020)]. Its medical importance comes because it contains antioxidants, where eating it cooked or in the form of

salads reduces the incidence of cancer by 60%, because it contains a substance (glucoraphanin), which enhances the body's immunity against cancer diseases, as it rids the body of the type of bacteria that helps to increase the possibility of cancer. stomach and compound (indole-3-carbinol). It is an antioxidant and carcinogen-resistant compound that prevents breast and colon cancer, and also promotes liver function [Salman and Abdul Razzaq (2022), Al-Falahi *et al.* (2022)]. The cultivated area in Iraq for the year 2018 amounted to about 953 hectares, with a total production of 11,285 tons and an average productivity of 11,841 tons.ha⁻¹, while the cultivated

area in the world amounted to 1,417,806 hectares, with a total production of 26,504,006 tons and an average productivity of 18.6937 tons.ha⁻¹ [FAO (2018)]. Foliar feeding is one of the preferred methods because, it is easy, economical and fast, and there are no soil problems with it, in addition to being positive with the micro and macro nutrients due to the large number of problems with some of these elements when added to the soil, which causes a decrease in its available for the plant [Ali *et al.* (2014), Toman *et al.* (2020)]. It is considered one of the successful methods for addressing the deficiency of elements, especially the minor ones, because many nutrients that are added to the soil do not benefit the plant except in small quantities, where a result of precipitation, fixation, or washing and then reducing its readiness, which is reflected negatively on plant growth [El-Emam and El-Ahmar (2003), AL-Taey *et al.* (2018)]. Foliar fertilization of micronutrients is a distinctive and effective method and its efficiency has been proven due to its addition in low concentrations and avoiding the possible side effects that may occur on the vegetative system, especially the leaves, such as burns, damage and wrinkling. As these elements were added in high concentrations, in addition to avoiding the occurrence of some problems in the calcareous soils that tend to be basic, which makes them not ready for absorption by the root system of the plant [Abu Dahi (2002), AL-Mohammad and AL-Taey (2019)]. Zaki *et al.* (2012) showed in a study on two cultivars of broccoli Calabrese and Southern star for two consecutive seasons, the Calabrese cultivar was significantly excelled in plant height, number of leaves and leaf area compared to the other cultivar and for both seasons. While, the southern star cultivar was significantly superior in the yield of main and lateral seeds and the total yield per unit area of the main and lateral seeds for both seasons. Abou El-Magd *et al.* (2015) mentioned in a study on two broccoli cultivars Sakura F₁ hybrid and Centauro for two consecutive seasons, they concluded that there were no significant differences in plant height, number of leaves, and percentage of dry matter in the leaves between the studied cultivars. While the Centauro cultivar was significantly excelled in leaf area and total yield per unit area of the main and side discs compared to the other cultivar for both seasons. Hannon *et al.* (2018) indicated in a study on two cultivars of broccoli Monaco and Paraiso during the winter season 2016-2017, the

Paraiso cultivar was significantly excelled in plant height and leaf area and they noted that there were no significant differences between the two cultivars in the number of leaves and the average total yield of the main and lateral discs of the plant. The one and the dry matter in the flowering discs. Al-Salhi (2019) explained that when studying two cultivars of broccoli, Polo and Paraiso, the Polo cultivar excelled in the Paraiso cultivar in the number of leaves, the chlorophyll content of the leaves, the average number of lateral flowering discs, and the dry weight of the flowering discs, while both cultivars did not differ in leaf area, weight of the main flowering disc, the yield of the experimental unit and the yield of the main and lateral flowering discs. Al-Zubaidi (2020) mentioned in a study on two hybrids of Paraiso and Danar broccoli for the agricultural season 2018-2019. The Paraiso hybrid was significantly excelled in number of leaves, leaf area, percentage of dry matter in the leaves, and yield per plant of the main flowering disc over the Danar hybrid. Whereas, both hybrids did not differ in plant height, chlorophyll content of leaves, number of lateral flowering discs, total yield of lateral flowering heads, and circumference of the main flowering head. Sarma *et al.* (2003) showed that spraying cabbage plants with boron at a concentration of 0.5%, this concentration led to a significant increase in the number of leaves compared to the control treatment. Singh *et al.* (2018) showed that spraying broccoli plants (Pusa KTS-1) with zinc sulfate, copper sulfate, iron sulfate, ammonium molybdate, and boric acid at a concentration of 0.20, 0.40 and 0.60% each, gave a treatment of zinc sulfate at a concentration of 0.60% in root length and flower stem length. Ain *et al.* (2016) indicated that spraying broccoli plants with boron at a concentration of 0, 0.25, 0.50, 1% and zinc at a concentration of 0, 0.25, 0.50 and 1%, gave zinc at a concentration of 0.5% a significant increase in plant height and number of leaves, while zinc was given at a concentration of 0.5%. 1% significant increase in the number of flowering discs in the plant. Al-Zubaidi (2020) stated that spraying two hybrids of Paraiso and Danar broccoli with zinc 300mg.L⁻¹ + Boron 60mg.L⁻¹ gave a significant increase in plant height, leaf area, leaf chlorophyll content, circumference of the main flowering disc, weight of the main flowering disc and the number of secondary discs compared to by spraying with zinc and boron separately.

2. Materials and Methods

The experiment was conducted in one of the fields of Al-Azzawiya region, AL-Mussaib district, 40km north of the center of the city of Hilla in the province of Babylon. The experiment included eight treatments, two cultivars of hybrid broccoli, Polo and Jassmine with four concentrations of Micronate 15 nutrient solution, 0, 1, 2 and 3g.L⁻¹ of water was sprayed. The plants were sprayed one month after seeding for three sprays and the period between one spray and another was two weeks and it was applied as a factorial experiment with two factors, according to the randomized complete block design with three replications, and the first factor counted the cultivars and includes:

A1: The Polo cultivar is a hybrid variety produced by the Dutch company Seeds Flora, with a germination rate of 90% and a purity of 99%.

A2: Jassmine is a hybrid cultivar produced by the American company Delta Seeds, with a germination rate of 90% and a purity of 99%.

The second factor is the nutrient solution Micronate 15 produced by the Jordanian Agro-Industrial Company and the concentrations of the nutrient solution include

b1: Spray with water only (control).

b2: 1 g.L⁻¹ of water.

b3: 2 g.L⁻¹ of water..

b4: 3 g.L⁻¹ of water..

Table 1: Components of the Micronate 15 nutrient solution, according to the manufacturer.

Fe	Z	Mn	MgO	B	Cu	Mo
4.00%	4.00%	3.00%	2.00%	1.50%	0.50%	0.05%

Random soil samples were taken from the field at a depth of (0-30 cm) from several sites and analyzed (Table 2).

Table 2: Physical and chemical properties of field soil.

Soil texture	Traits								
	Silt	Sand	Clay	K (mg.kg ⁻¹)	P (mg.kg ⁻¹)	N (mg.kg ⁻¹)	Organic matter %	Ece ds.m ⁻¹	pH
	%								
Loamy sand	24.5	60	15.5	192.0	5.6	13.4	1.13	4.5	8.0

The experimental land was tillage with two perpendicular tillage by the Moldboard plows, then smoothed and leveled, and then the land was divided into three sectors, and each sector was divided into experimental units, where the total number of

experimental units reached 24 units. As the length of the experimental unit was 3m and the width was 0.5m, leaving a distance of 0.75m between sectors and experimental units for the purpose of preventing confusion between treatments. Broccoli seeds were sown on 8/27/2020 in cork dishes after filling them with peat moss as an agricultural medium in one of the nurseries, with one seed per eye, inside a canopy covered with a green saran cover, to reduce the sun's rays while providing the appropriate conditions for the growth of the seedlings. After the seedlings reached the stage of 4-5 true leaves, they were transferred to the permanent field and planted on 10/7/2020. Planting took place at the rate of 10 seedlings per experimental unit and the distance between one line and another was 75 cm. The distance between one plant and another was 40cm, and one seedling was planted in each pot, and the process of grafting the seedlings was carried out a week after planting, and all agricultural operations were conducted such as irrigation, insect control, disease control, and weeds removal, and the irrigation system was drip irrigation.

2.1 Studied traits

Vegetative traits: Five plants were selected from each experimental unit for readings.

Plant height (cm): Measure the plant height from the area of contact with the soil to the highest leaf on the plant chosen for the experimental units and extract the rate by metric tape.

Number of leaves (leaf.plant⁻¹): The number of total leaves for each of the plants selected for the experimental units was calculated and the average was extracted.

Dry weight of vegetative growth (g): This traits was calculated after five plants were extracted, washed and dried in an electric oven at 70°C for 72 hours until the weight is stable and the average is extracted.

2.2 Quantitative traits

Diameter of the main flowering disc (cm): It was calculated according to the diameter of the mature flowering discs by metric measurement of the widest area of the disc surface of the selected plants and

calculating the average for it.

Weight of the main flowering disc (gm): It was calculated by taking the weight of the main ripe flowering discs of five plants from each experimental unit and calculating the average for it.

Number of lateral heads (head.plant⁻¹): The number of lateral heads (lateral flowering discs) on the main stem of the plant was counted until the end of the growing season.

The total yield of the plant (g. plant⁻¹): The total weight of the main flowering disc and the weight of the lateral flowering discs were calculated for each plant of the experimental unit.

The results were analyzed according to the used design and the least significant difference (L.S.D) test was used to compare the averages at the probability level of 0.05 [Al-Sahoki and Wahib (1990)].

3. Results and Discussion

Vegetative traits

The results in Table 3 showed that the two cultivars

differed significantly in the vegetative traits represented in the rate of plant height, the number of leaves, and the dry weight of vegetative growth. The Polo cultivar excelled in the average of the above traits, reaching 62.58cm, 37.33 leaves and 247.7g, respectively, while the Jassmine cultivar reached 54.92cm, 30.25 leaves and 234.4g, respectively. The results showed that the foliar spraying with the nutrient solution Micronate 15 had a significant effect on the average of the above traits. The spraying treatment with a concentration of 3g.L⁻¹ liter of water achieved the highest rate, as it reached 67.17cm, 44.00 leaves, and 308.0gm. It was significantly excelled on other spraying treatments. The results of the same table also showed that the interaction between the hybrid cultivar and foliar spraying with the nutrient solution Micronate 15 had a significant effect on the rate of plant height, number of leaves and dry weight. Where the interaction treatment between the Polo cultivar and spraying at a concentration of 3g.L⁻¹ water was significantly excelled in the average of plant height, number of leaves and dry weight, as it reached 63.33cm, 41.67 leaves and

Table 3: The effect of cultivar and spraying with the nutrient solution Micronate 15 and the interaction between them on the vegetative traits of broccoli plant.

Cultivars A	Concentrations B	Plant height average	The average number of leaves	The dry weight of the vegetative growth
Polo	Control (without spraying)	55.33	28.67	198.7
	1 g.L ⁻¹ water	59	33.67	209.7
	2 g.L ⁻¹ water	65	40.67	317.3
	3 g.L ⁻¹ water	71	46.33	265
Jassmine	Control (without spraying)	47	21.33	189.7
	1 g.L ⁻¹ water	53.33	25	200
	2 g.L ⁻¹ water	56	33	298.7
	3 g.L ⁻¹ water	63.33	41.67	249.3
L.S.D0.05(AxB)		2.48	2.36	12.16
Cultivar average		62.58	37.33	247.7
		54.92	30.25	234.4
L.S.D0.05 (A)		1.24	1.18	6.08
Spraying average		51.17	25	194.2
		56.17	29.33	204.8
		60.5	36.83	257.2
		67.17	44	308
L.S.D0.05 (B)		1.75	1.67	8.6

Table 4: The effect of cultivar and spraying with the nutrient solution Micronate 15 and the interaction between them on the yield traits of broccoli plant.

Cultivars A	Concentration B	Diameter of the main flowering disc	Weight of the main flowering disc	Number of lateral heads	Total plant yield from main and lateral flowering discs
Polo	Control (without spraying)	16	390	3.64	556.7
	1 g.L ⁻¹ water	19	431.7	4.89	622.7
	2 g.L ⁻¹ water	21.33	504.3	6.44	717.3
	3 g.L ⁻¹ water	22.67	563.3	5.97	834
Jassmine	Control (without spraying)	19	455.7	4.71	710
	1 g.L ⁻¹ water	21.67	480	5.94	752.3
	2 g.L ⁻¹ water	23.33	564	7.73	819
	3 g.L ⁻¹ water	25.67	644	6.6	963.7
L.S.D 0.05(AxB)		1.38	26.97	0.95	24.24
Cultivar average		19.75	472.3	5.23	682.7
		22.42	535.9	6.24	811.2
L.S.D 0.05 (A)		0.69	13.48	0.47	12.12
Spraying average		17.5	422.8	4.18	633.3
		20.33	455.8	5.41	687.5
		22.33	534.2	6.28	768.2
		24.17	603.7	7.08	898.8
L.S.D 0.05 (B)		0.98	19.07	0.67	17.14

249.3gm on the other interaction treatments, while the treatment of interaction between Jassmine cultivar, when not sprayed, had the lowest rate, as it reached 55.33cm, 28.67 leaves and 198.7grams, respectively.

The results in Table 4 showed that the two cultivars differed significantly in the traits of the yield, represented in the average diameter of the main flowering disc, the weight of the main flowering disc, The number of lateral heads and total yield were 6.24 head .plant⁻¹ and 811.2 gm.plant⁻¹ respectively. When in the Polo cultivar it reached 19.75cm, 472.3g and 5.23 head. plant⁻¹ and 682.7 g. plant⁻¹, respectively. The results showed that the foliar spraying with the nutrient solution Micronate 15 had a significant effect on the average of the above traits. All spraying treatments showed significant superiority in the diameter of the main flowering disc, the weight of the main flowering disc and the total plant yield compared to the control treatment. The spraying treatment with a concentration of 3g.L⁻¹ of water achieved the highest average, as it reached 24.17cm,

603.7gm and 7.08 head.plant⁻¹ and 898.8 gm.plant⁻¹ was significantly excelled on other spraying treatments. The results of the same table also showed that the interaction between the hybrid cultivar and the foliar spraying with the nutrient solution Micronate 15 had a significant effect on the diameter of the main flowering disc, the weight of the main flowering disc, the number of side discs, and the total yield of the plant. The treatment of the interaction between the Jassmine cultivar and the spraying at a concentration of 3g.L⁻¹water was significantly excelled in the average diameter of the main flowering head, the weight of the main flowering head, the number of side heads and the total yield of the plant, as it reached 25.67 cm, 644.0g and 6.60 heads.plant⁻¹ and 963.7 gm. plant⁻¹ on other interaction treatments. While the interaction treatment between the Polo cultivar when not sprayed gave the lowest rate, as it reached 16.00cm, 390.0gm and 3.64 head.plant⁻¹ and 556.7 gm.plant⁻¹, respectively.

The above results showed that there are significant differences between the two hybrids and the reason is due to the nature of the genetic makeup of the hybrid and its suitability for the conditions of the region in which it is cultivated and this is consistent with Zaki *et al.* (2012), Abou El-Magd *et al.* (2015), Hannon *et al.* (2018), Al-Salhi (2019) and Al-Zubaidi (2020) on broccoli. The significantly excelled of spraying with the nutrient solution (Micronate 15) may be due to the fact that it contains a number of nutrients that fill the needs of the vegetative system, which leads to an increase in cell division and expansion, and then an increase in the width of the leaves and an improvement in the strength of the vegetative growth of the plants, thus increasing the efficiency of photosynthesis and the content of the leaves of chlorophyll as a result of the foliar spraying which ultimately leads to an increase in vegetative growth [Singh (2003), AL-Taey *et al.* (2022)]. The results showed the significantly excelled of the interaction treatment between genotype and nutrient content of microelements. The results showed a positive effect in increasing vegetative traits and yield. The reason may be due to the important physiological roles played by the nutrient solution (Micronate 15) containing microelements in improving vegetative growth traits and yield. This is in agreement with Zaki *et al.* (2012), Abou El-Magd *et al.* (2015), Hannon *et al.* (2018), Al-Salhi (2019) and Al-Zubaidi (2020) on broccoli, Singh *et al.* (2018), Ain *et al.* (2016), Patel *et al.* (2017) on broccoli and AL-Baytati (2019) on cauliflower and AL-Taey *et al.* (2019) on cabbage. It is concluded from this study that the Polo cultivar showed a significantly excelled on the Jassmine cultivar in vegetative growth traits, while the Jassmine cultivar gave a significantly excelled on the Polo cultivar in yield traits. Foliar spraying at a concentration of 3gm.L⁻¹ water led to a significant increase in the vegetative growth and yield traits of broccoli plant. It was found that the interaction between the hybrid cultivar and spraying at a concentration of 3g.L⁻¹ of water gave the best rate of vegetative growth and yield during the growing season.

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References

- Abou El-Magd, M.M., M.F. Zaki and S.A. Abou Sedera (2015). Growing two broccoli cultivars under different mineral and foliar fertilization treatments. *J. Innov. Pharmaceut. Biol.*, **2(4)**, 620-631.
- Abu Dahi, Y.M. (2002). The effect of foliar feeding with nitrogen, phosphorus and potassium elements and their efficiency compared to adding them to the soil of vegetable crops under protected cultivation conditions. *The Second National Scientific Conference on Soil and Water Resources*, College of Agriculture, University of Baghdad, Iraq.
- Ain, Q., G. Ayub, M. Ilyas, M. Ahmad, F. Begum, Luqman, A. Saeed, M.I. Khan and K. Shah (2016). Response of broccoli to foliar application of zinc and boron concentrations. *Pure Appl. Biol.*, **5(4)**, 841-846.
- AL-Bayati, H.J.M. (2019). Growth and yield of Cauliflower as effected by boron and fertilizer type. *Int. J. Agricult. Stat. Sci.*, **15(2)**, 595-599.
- Al-Falahi, M.N.A., K.H. Al-Dulaimi, E.T.A. Ghani, D.K.A. Al-Taey and K.J. Farhan (2022). Effect of Humic acids and the amount of Mineral fertilizer on some characteristics of Saline soil, growth and yield of Broccoli plant under salt stress conditions. *Agraarteadus*, **32(1)**, 11-20. <https://doi.org/10.15159/jas.22.24>
- Ali, N.S., H. Suleiman and A.A. Shaker (2014). *Soil fertility*. Scientific books house, College of Agriculture, University of Baghdad, Iraq.
- AL-Mohammad, M.H. and D.K.A. AL-Taey (2019). Effect of tyrosine and sulfur on growth, yield and antioxidant compounds in arugula leaves and seeds. *Res. Crops*, **20(1)**, 116-120. DOI: 10.31830/2348-7542.2019.016
- Al-Sahoki, M. and K.M. Wahib (1990). *Applications in the Design and Analysis of Experiments*. Baghdad University. Ministry of Education and Scientific Research, Iraq.
- Al-Salhi, M.G.M. (2019). Effect of spraying concentrations of seaweed extract (Acadian) and planting dates on the growth and yield characteristics of two hybrids of broccoli Brassica oleracea var. italic. *Master's Thesis*, College of Agriculture, University of Kirkuk. Ministry of Higher Education and Scientific Research, Republic of Iraq.
- AL-Taey, D.K.A., A.H. Al-Janabi and A.M. Rachid (2019). Role of Additive in Mitigation of the Negative effects of Saline Water on Cabbage (*Brassica oleracea* var. Capitata L). *Plant Archives*, **19(Supplement 1)**, 78-85.
- AL-Taey, D.K.A., S.S.M. AL-Azawi, M.J.H. AL-Shareefi and A.R. AL-Tawaha (2018). Effect of saline water, NPK and organic fertilizers on soil properties and growth,

- antioxidant enzymes in leaves and yield of lettuce (*Lactuca sativa* var. Parris Island). *Res. Crops*, **19**, 441-449. DOI: 10.31830/2348-7542.2018.0001.14
- AL-Taey, D.K.A., S.S. Alflawi and M.R. Sahib (2022). Effect of Zytonic-M, palm wastes compost and NPK on the growth and yield of tomato under Salt Stress Conditions. *Int. J. Agricult. Stat. Sci.*, **18(2)**, 829-836. DocID: <https://connectjournals.com/03899.2022.18.829>
- Al-Zubaidi, N.Z. (2020). Effect of seeding dates and spraying with zinc sulfate and boron on the growth and yield of two broccoli hybrids (*Brassica oleracea* var. *italica*). *Ph.D. Thesis*. College of Agriculture and Forestry, University of Mosul, Ministry of Higher Education and Scientific Research, Republic of Iraq.
- El-Emam, S.T. and B.A. El-Ahmar (2003). Effect of NK levels on some economic characters of sesame and sunflower. *Letter*, **18**, 101-107.
- Food and Agricultural Organization (FAO) (2018). *International Production of Cauliflower and Broccoli*. Agricultural Organization, Rome, Italy.
- Hamza, O.M. and D.K.A. AL-Taey (2020). A study on the effect of glutamic acid and benzyl adenine application up on growth and yield parameters and active components of two Broccoli hybrids. *Int. J. Agricult. Stat. Sci.*, **16(Supplement 1)**, 1163-1167. DocID: <https://connectjournals.com/03899.2020.16.1163>
- Hannon, A.A., N.J. Mohamed and N.M. Hammoud (2018). Effect of nitrogen fertilization on two hybrids of broccoli *Brassica oleracea* var. *italica* Plenck. broccoli and yield content of NPK elements. *Dhi Qar University Journal of Agricultural Research*, **7(1)**, 440-426.
- Lashkari, C.O., A.N. Makwana and M.A. Meman (2007). Effect of zinc and iron on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis*) c.v snowball-16. *The Asian Journal of Horticulture*, **2(2)**, 277-279.
- Mariush, A.H. and M.Z. AL-Mharib (2020). Effect of Nano-fertilizers and Amino acids on the growth and yield of Broccoli. *Int. J. Agricult. Stat. Sci.*, **16(Supplement 1)**, 1661-1665. DocID: <https://connectjournals.com/03899.2020.16.1661>
- Patel, A., S. Maji, K.R. Meena and N.K. Malviya (2017). Use of boron and molybdenum to improve broccoli production. *J. Crop Weed*, **13(2)**, 20-24.
- Salman, A.D. and A.H. Abdul Razzaq (2022). Effect of Cultivation dates and different sources of Soil Fertilization on Vegetative Characteristics, Quality and Yield of Broccoli. *Int. J. Agricult. Stat. Sci.*, **18(1)**, 165-171. DocID: <https://connectjournals.com/03899.2022.18.165>
- Sarma, P., R.K. Goswami and B.C. Deka (2003). Effect of foliar application of micronutrients on growth characters of cabbage (*Brassica oleraceae* capital) under Assam condition. *Orissa Journal of Horticulture*, **31(2)**, 51-53.
- Singh, A. (2003). *Fruit Physiology and Production* 5th Edition. Kalyani Publishers, New Delhi.
- Singh, V., A.K. Singh, S. Singh, A. Kumar and D.P. Mohrana (2018). Impact of foliar spray of micronutrients on growth, yield and quality of broccoli (*Brassica oleracea* var. *italica*) cv. Pusa KTS-1. *The Pharma Innov. J.*, **7(8)**, 99-101.
- Toman, S.S., D.K.A. AL-Taey, A.R. Al-Tawaha, S.N. Sirajuddin, I. Rasyid and A.A. Hassan (2020). Effect of foliar application and mineral fertilizer on growth parameters and content auxins, GA and CK in cucumber leaves. *IOP Conf. Ser.: Earth Environ. Sci.*, **492**, 012009, DOI:10.1088/1755-1315/492/1/012009
- Zaki, M.F., A.S. Tantawy, S.A. Saleh and Y.I. Helmy (2012). Effect of bio-fertilization and different levels of nitrogen sources on growth, yield components and head quality of two broccoli cultivars. *J. Appl. Sci. Res.*, **8(8)**, 3943-3960.

