EFFECT OF MAGNATIC WATER AND SPRYING WITH SILICON, ZOLFAST ON SOME GROWTH AND YEILDES ON CAULIFLOWER (*Brassica oleracea L.* var. botrytis)

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Abstract

The experiment was conducted during tow growing season (2018-2019 and 2019-2020) in sandy clay soil in a field belonging to tomato development project Al-Zubair/ Directorate for Agriculture of Basra province . The study aim effect of Magnetic water and foliar spraying with Silicon and Zolfast on growth and yield of cauliflower plant.Its included 18 treatments, which consisted of the interaction between two levels of magnetization of irrigation water (Magnetic and without), spraying with three concentrations of silicon K2SiO3 (0, 1 and 1.5) $ml.L^{-1}$ and Zolfast (0, 2.5 and 3.5) $ml.L^{-1}$ by three sprays after 20 days of transplanting. It was conducted as Split Split Plot Design by Randomized Complete Block Design (R.C.B.D) with three replicates, the least significant difference test (L.S.D) was used to compare the averages at a probability level of 0.05. The results may be summarized as follows:

The Magnetic water was gave a significant increase in the both season in the maturity time curd, but in the first season was significant at the curd diameter, weight of curd (500.2)g in addition the total yield (14.67) tons ha^{-1}, but in the second season Magnetic water was significant in the plant height, number of leaves, leaf area, and the curd diameter. Results showed that the spraying with Silicon gave a significant increase in all vegetative and yield traits under the experiment, the time of ripening curd, diameter of the curd, weight of curd (502.2, 567.1) g in addition the total yield (14.73 , 16.64) $tons.ha^{-1}$ in the both season respectively. Zolfast gave a significant increase in all vegetative and yield traits under the experiment the maturity time of curd, curd diameter, weight of curd (575.1, 602.2) g in addition total yield (16.87,17.66) tons ha^{-1}, in both season respectively.

Keywords: Cauliflower, Zolfast, Potassium silicate.

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تأثير مغنطة مياه الري والمعاملة بالسليكون و الزولفاست في النمو والحاصل لنبات القرنابيط *Brassica oleracea* L. var. botrytis

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الخلاصة

نفذت الدراسة أثناء الموسمين الشتويين 2018- 2019، 2019 – 2020 في مشروع تطوير زراعة الطماطة بالتقنيات الحديثة التابع لمديرية زراعة البصرة في خور الزبير- محافظة البصرة، لدراسة تأثير مغنطة المياه والرش بالسليكون والزولفاست في نمو وحاصل نبات القرنابيط صنف نهار، إذ تضمنت التجربة 18 معاملة عاملية هي عبارة عن التداخل بين مستويين من مغنطة ماء الري (مغنطة وبدون مغنطة) وثلاث مستويات من السليكون على صورة سليكات البوتاسيوم K_2SiO_3 (0 ، 1 و 1.5) مل لتر$^{-1}$ رشاً على المجموع الخضري وثلاث مستويات من مستحضر الكبريت السائل (الزولفاست) (0 ، 2.5 و 3.5) مل لتر$^{-1}$، وبواقع ثلاث رشات بعد 20 يوماً من الشتل. نفذت كتجربة عاملية منشقة لمرتين (Split Split -Plot Design) وحسب تصميم القطاعات العشوائية الكاملة بثلاث مكررات، وأُستعمل اختبار أقل فرق معنوي (L.S.D) لمقارنة المتوسطات عند مستوى احتمال 0.05. وأهم النتائج التي تم الحصول عليها هي:-

تفوقت مغنطة المياه معنوياً في ارتفاع النبات، عدد الأوراق، المساحة الورقية و معدل قطر القرص الزهري في الموسم الثاني، في حين تفوقت نباتات الموسم الأول في وزن القرص الزهري (500.2) غم والحاصل الكلي (14.67) طن هكتار$^{-1}$، اما موعد نضج القرص الزهري فقد تفوقا في كلا موسمي النمو. اما بالنسبة لعامل السليكون فقد اظهر زيادة معنوية في جميع مؤشرات النمو الخضري في كلا موسمي النمو كذلك في مؤشرات الحاصل المتمثلة في موعد نضج القرص الزهري، قطر القرص الزهري، وزن القرص الزهري (502.2، 567.1)غم والحاصل الكلي (14.73، 16.64) طن هكتار$^{-1}$ ، للموسمين على التوالي. اما عامل الزولفاست فقد اثر معنويا في جميع مؤشرات النمو الخضري قيد التجربة في موسمي النمو كذلك في مؤشرات الحاصل المتمثلة في موعد نضج القرص الزهري، وزن القرص الزهري (575.1، 602.2)غم والحاصل الكلي (16.87، 17.66) طن هكتار$^{-1}$.

الكلمات المفتاحية : قرنابيط ، زولفاست ، سليكات البوتاسيوم
*البحث مستل من اطروحة دكتوراه للباحث الأول .

Introduction

Cauliflower (*Brassica oleracea* L. var. botrytis) is a winter annual crop belonging to the Brassicaceae family, cultivated with the aim of obtaining the fleshy flowering discs (curds) (15).It is morphologically similar to broccoli and Cabbage and is very sensitive to hot and dry weather(29). The plant is considered one of the medium tolerant plants to salinity, where it ranks fifth in horticultural crops, as it can give 50% of the total production or more at an electrical conductivity of 10 dSiemens, according to the data proposed by the salinity laboratory in the United States of America (35).Arid and semi-arid areas in the world face problems of soil and water salinity, which affect the growth and yield of plants by directly affecting plant growth, the efficiency of carbon metabolism and respiration, in addition to their impact on the availability of nutrients and the increase of free radicals (Reactive Oxygen Species (32), As it is known that cauliflower is a medium sensitive to salinity plant, where its production begins to deteriorate with the increase in the salinity of the irrigation water. Therefore, it is necessary to find the necessary methods and steps to reduce the negative role of saline well water in land productivity and soil pollution (33). Irrigation water magnetization technology is one of those solutions that has emerged in the past years because of its important role, especially when irrigation water is scarce. The use of this technology leads to the provision of significant quantities of water for use in irrigation, so resorting to this technology is necessary under conditions of water scarcity in different regions of Iraq, especially the southern regions (13) .Silicon is one of the most abundant elements in the soil, but its addition to the plant works to resist non-living stresses as well as stimulate anti-oxidation systems (25), which may lead to an increase in plant activity, especially in areas with high temperatures, and silicon has beneficial effects on plant growth under Inappropriate conditions for growth such as salt stress, metal toxicity, nutritional imbalance, drought, radiation, high temperatures, freezing and ultraviolet rays, and most of the beneficial effects are attributed to its deposition in plant tissues in the cell walls of roots, leaves, and stems, which provides a mechanical barrier against the effects External (24);) (36) (5) indicated through his study on two cultivars of tomato plants of limited growth under saline stress conditions that were sprayed with potassium silicate at five levels: 0, 50, 100, 150, and 200 mg.L^{-1}, where treatment with silicon had a significant effect on plant height. Leaves and leaf area of the total yield and the highest values of increase were obtained at the additional level of 200 mg.L^{-1} for both seasons.It was also found (10) when the cucumber plant (*Cucumis sativus* L.) was treated with four levels of sodium silicate which are 0, 50, 100, and 150 mg.L^{-1}, the level of 150 mg.L^{-1} was significantly excelled on the rest of the levels in plant height, a number of leaves and leaves area in addition to the plant yield.Sulfur can be considered one of the main nutrients after nitrogen, phosphorous, and potassium, and it is an essential element for plant growth because it is present in the main metabolic compounds such as amino acids such as methionine, cysteine , and proteins, so its deficiency reduces the quality and quantity of the crop (20). (7) When

spraying cauliflower, spraying plants with liquid sulfur Zolfast 82% at three levels of 0, 1, and 2 ml.L^{-1}, the level of 2 ml L^{-1} was significantly excelled in plant height that reached 39.72 cm and the number of leaves reached 20.02 leaves compared with control treatment. It was also noted that there was a significant effect that led to a significant increase with the increased levels of zolfast added in the curds diameter , the curds weight at the level of 2 ml.L^{-1}, reaching 29.02 cm, 1.24 kg.$plant^{-1}$, respectively for the mentioned traits.

Materials and methods

The study was conducted during the winter seasons 2018-2019 and 2019-2020 in a sandy loam, the electrical conductivity of which was 7.40 and 7.10 dSi and its pH was 7.55 and 7.23 for the two seasons, respectively.While the degree of electrical conductivity of irrigation water (the well) was 16.55 and 12.25 dS.m^{-2}, respectively, for the two study seasons in the project to develop tomato cultivation with modern technologies of the Basra Agriculture Directorate in Khor Al-Zubayr - Basra province, which is 31 km away from the center of the province on a longitude of 47.0 degrees. And a latitude of 30.29 degrees.Where a magnetization device with an intensity of 3000 gauss ((Magnetic and without),) was used and spraying with silicon in the form of potassium silicate K2SiO3, Sub-Plot included three levels: 0, 1, and 1.5 ml.L^{-1} and spraying with liquid sulfur (Zolfast).The Sub - Sub - Plots included three levels of 0, 2.5 and 3.5 ml.L^{-1} and by three sprays for both factors, the first spray after 20 days of sowing and between one spray and another fourteen days. The averages of the results were statistically analyzed using the statistical program Genstat for each season respectively and the Least Significant Differences Test (LSD) was used to compare means at the 0.05 (8) probability level.

experimental measurements

The readings were taken from five plants that were randomly selected in advance from each experimental unit and then the average was calculated for each plant and included:

Plant height (plant.cm^{-1}), total number of leaves (leaf.$plant^{-1}$), leaf area (cm^2.$plant^{-1}$), date of maturity and harvest 10% of curds (day), curds diameter (plant.cm^{-1}), Average curds weight (g.$plant^{-1}$) and total yield (ton.ha^{-1}).

Results and discussion

Table (1) shows the plants treated with magnetized water excelled in plant height in the second season only, where it gave the highest plant height of 38.59 cm.$plant^{-1}$ compared to the lowest plant height was 35.70 cm plant-1 for plants not irrigated with magnetized water.It is also noted that the plants treated at the level of 1 ml.L^{-1} silicon in the first season were significantly excelled in this trait, as it reached 34.75 cm.$plant^{-1}$ at the levels 0 and 1.5 ml.L^{-1}, they reached 31.64 and 32.25 cm.$plant^{-1}$, respectively, but in the season The second level gave the two levels 1, 1.5 ml.L^{-1} the highest height, which reached 38.17 and 37.67 cm.$plant^{-1}$, respectively, compared to the control treatment that gave the lowest height was 35.61 cm.$plant^{-1}$.The same table shows plants treated with the level 3.5 ml.L^{-1} of Zolfast significantly excelled in the first season, which gave the highest height of 33.71 cm.$plant^{-1}$ compared to 32.16 cm plant-1 for the control treatment, and the level of 2.5 ml.L^{-1} had a significant difference with the other two concentrations. In the second season, the level of 3.5 ml.L^{-1} of 38.56 cm.$plant^{-1}$ was significantly excelled on the other two levels, and the level of 2.5 ml.L^{-1} of 37.44 cm.$plant^{-1}$ was excelled on the control treatment that gave the lowest height was 35.44 cm.$plant^{-1}$.It appears from the same table that the bi-interaction between magnetizing factors and silicon as well as magnetization and Zolfast had no significant effect on this trait for the two growing seasons, while the bi-interaction between Silicon and Zolfast was excelled. The cauliflower plants in the first season treated with a level of 1 ml.L^{-1} silicon and 2.5 ml L^{-1} Zolfast showed the highest plant height of

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36.20 cm.plant^{-1} compared to the lowest height was 29.27 cm.plant^{-1} produced in plants treated with 1 ml.L^{-1}. silicone only,In the second season, plants treated with 1.5 ml.L^{-1} silicon and 3.5 ml.L^{-1} Zolfast were excelled and gave 39.17 cm.Plant^{-1} compared to 33.33 cm.Plant^{-1} produced in the control plants for both factors.

Table (1) Effect of water magnetization and spraying with Zolfast and silicon and their interactions on plant height (plant.cm^{-1}) of cauliflower, cultivar Nahar

Magnetic water	Zolfast ml.L^{-1}	season (2018-2019) Silicon ml.L^{-1} 0	1	1.5	magnetization X Zolfast	season (2019-2020) Silicon ml.L^{-1} 0	1	1.5	magnetization X Zolfast
Magnetic	0	30.45	32.78	33.62	32.28	35.67	37.67	37.67	37.00
	2.5	30.78	36.99	31.89	33.22	38.00	40.00	39.00	39.00
	3.5	33.52	36.11	30.74	33.46	38.33	40.67	40.33	39.78
Without Magnetic	0	32.04	33.20	30.85	32.03	31.00	36.33	34.33	33.89
	2.5	27.77	35.41	32.74	31.97	34.00	37.00	36.67	35.89
	3.5	34.23	34.00	33.65	33.96	36.67	37.33	38.00	37.33
LSD 0.05		3.57			N.S	2.31			N.S
silicon		31.46	34.75	32.25	Magnetic	35.61	38.17	37.67	Magnetic
LSD 0.05		1.51				1.74			
magnetization X silicon	Magnetic	31.58	35.29	32.08	32.99	37.33	39.44	39.00	38.59
	Without Magnetic	31.34	34.21	32.41	32.65	33.89	36.89	36.33	35.70
LSD 0.05		N.S			N.S	N.S			1.27
					Zolfast				Zolfast
Zolfast X silicon	0	31.24	32.99	32.23	32.16	33.33	37.00	36.00	35.44
	2.5	29.27	36.20	32.31	32.60	36.00	38.50	37.83	37.44
	3.5	33.88	35.06	32.20	33.71	37.50	39.00	39.17	38.56
LSD 0.05		2.40			1.43	1.87			0.62

As for the triple interaction between the experimental factors, it was significant, as the first season plants irrigated with magnetized water and treated with a level of 1 ml.L^{-1} silicon and 2.5 ml.L^{-1} Zolfast gave the highest height of 36.99 cm plant-1 compared to the lowest height was 27.77 cm plant-1 In plants irrigated with magnetized water and 2.5 ml.L^{-1} zolfast only, In the second season, plants irrigated with magnetized water, 1 ml L^{-1} silicon and 3.5 ml.L^{-1}, Zolfast, excelled on plants irrigated with magnetized water, which were 40.67 cm plant-1, compared to the lowest

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height was 31.00 cm.plant^{-1} produced in plants irrigated with non-magnetized water only.

Table (2) shows the effect of magnetization of water and spraying with zolfast and silicon and their interaction on the number of leaves for the two growing seasons. It is noted that there was no significant effect of water magnetization in this trait in the first season, while the plants treated with magnetized water significantly excelled in the second season, reaching 15.67 leaves.plant^{-1}. Compared with the lowest number of leaves, which was 14.67 leaves.plant^{-1}without magnetization. It is also noted that the level of 1.5 ml L^{-1} of silicon was significantly superior in the first season, which amounted to 16.59 leaves.plant^{-1}, compared to the level of 1 ml.L$^{-1,}$ which amounted to 16.39, while the control treatment did not have a significant difference with the other two levels. In the second season, levels 1, 1.5 ml.L^{-1} showed a significantly excelled of 15.39 leaves.plant^{-1} on the control treatment, which was 14.72 leaves.plant^{-1}. The table also shows that the level of 3.5 ml.L^{-1} of Zolfast in the first season was excelled and gave 15.67 leaves-1 at the levels 0, 2.5 ml.L^{-1}, which gave 15.90 and 16.24 leaves.plant^{-1}, respectively. In the second season, the level of 3.5 ml.L^{-1} also recorded a significantly excelled of 15.67 leaves.plant^{-1} compared to the other two levels, while the level of 2.5 ml.L^{-1} was excelled on the control treatment that gave the lowest number of leaves amounted to 14.61 leaves.plant^{-1}.The same table shows that the bi-interaction between magnetizing factors and silicon was significant in the first season only, where the plants treated with magnetized water and 1.5 ml.L^{-1} silicon gave the highest number of leaves that reached 17.13 leaves.plant^{-1}compared to plants treated with magnetized water and 1 ml.L^{-1} compared to plants treated with magnetized water and 1 ml.L^{-1} where it gave the lowest number of leaves, which was 15.83 leaves.plant^{-1},While the bi-interaction between magnetization and Zolfast had no significant effect in both growing seasons. As for the bi-interaction between the two factors silicone and Zolfast, it was significant in the first season only. The plants treated at the level of 0 ml.L^{-1} silicon and 3.5 ml.L^{-1} Zolfast gave the largest number of leaves that reached 17.65 leaves-1 compared to the control treatment for both factors, which recorded the lowest Number of leaves was 15.17 leaves.plant^{-1}.As for the triple interaction between the study factors, it had no significant effect on this trait and in both growing seasons.

Table (2) Effect of water magnetization and spraying with Zolfast and silicon and their interactions on the number of leaves(leaves.plant^{-1})of cauliflower, cultivar Nahar

Magnetic water	Zolfast ml.L^{-1}	season (2018-2019)			magnetization X Zolfast	season (2019-2020)			magnetization X Zolfast
		Silicon ml.L^{-1}				Silicon ml.L^{-1}			
		0	1	1.5		0	1	1.5	
Magnetic	0	16.00	15.77	17.19	16.32	14.34	15.67	15.33	15.12
	2.5	16.90	15.89	16.37	16.37	15.34	15.67	16.34	15.78
	3.5	17.30	15.83	17.89	17.01	15.67	16.34	16.34	16.12
Without Magnetic	0	14.34	16.21	15.87	15.47	13.67	14.34	14.34	14.12
	2.5	15.82	16.67	15.84	16.11	14.67	14.67	14.67	14.67
	3.5	18.00	16.40	16.45	16.95	14.67	15.67	15.34	15.23
LSD 0.05		N.S			N.S	N.S			N.S
silicon		16.3	16.1	16.5	Magnetic	14.7	15.3	15.3	Magnetic

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		9	3	9		3	9	9	
LSD 0.05		0.48				0.36			
magnetization X silicon	Magnetic	16.73	15.83	17.13	16.57	15.12	15.89	16.00	15.67
	Without Magnetic	16.05	16.43	16.05	16.18	14.34	14.89	14.78	14.67
LSD 0.05		0.50			N.S	N.S			1.00
					Zolfast				Zolfast
Zolfast X silicon	0	15.17	15.99	16.53	15.90	14.00	15.00	14.84	14.62
	2.5	16.36	16.28	16.08	16.24	15.00	15.17	15.00	15.23
	3.5	17.65	16.12	17.17	16.98	15.17	16.00	15.84	15.67
LSD 0.05		0.80			0.53	N.S			0.37

Table (3) shows the effect of magnetization of water and spraying with zolfast and silicon and their interaction on the leaf area of the two growing seasons. It is noted that there was no significant effect of water magnetization in this trait in the first season, while the plants treated with magnetized water significantly excelled in the second season, reaching 7638 $cm^2.plant^{-1}$ compared to The lowest leaf area was 6983 cm^2 $plant^{-1}$ in without magnetization.It was also noted that the level of 1.5 $ml.L^{-1}$ silicon was significant in the first season, which amounted to 5443 cm $^2.plant^{-1}$ compared to the control treatment, which gave the least leaf area was 4955 cm ^{2} $plant^{-1}$, while the level of 1 $ml.L^{-1}$ had no significant difference from the other two levels. In the second season, the level 1.5 $ml.L^{-1}$ showed significantly excelled on the other two levels, which amounted to 7616 cm 2 plant-1, and the level of 1 $ml.L^{-1}$ was excelled on the control treatment that gave the lowest leaf area was 6968 cm $^2.plant^{-1}$.The table shows that the level of 2.5 $ml.L^{-1}$ Zolfast was significantly excelled in the first season, which amounted to 5443 $cm^2.plant^{-1}$, compared to the level 3.5 $ml.L^{-1}$ Zolfast, which gave the least leaf area was 5037 cm^2 $plant^{-1}$, while the control treatment had no significant difference with The other two levels, while in the second season, the level 3.5 $ml.L^{-1}$ Zolfast was significantly excelled to 7595 $cm^2.plant^{-1}$ compared to the other two levels, and the level 2.5 was excelled on the control treatment that gave the least leaf area amounted to 6975 cm2 $plant^{-1}$.It is clear from the same table that the bi-interaction between magnetizing factors and silicon was significant, where plants irrigated with magnetized water and treated with the level of 1.5 $ml.L^{-1}$ silicon significantly excelled in the first season it was 6144 cm $^2.plant^{-1}$ compared to plants irrigated with magnetized water and distilled water the least leaf area amounted to 4601 cm2.$plant^{-1}$,In the second season, the plants treated with the level of 1.5 ml L-1 silicon and irrigated with magnetized water were significantly excelled to 8055 cm^2 $plant^{-1}$ compared to the lowest leaf area was 6683 cm^2 $plant^{-1}$ produced in the control plants irrigated with non-magnetized water. Zolfast was not significant in both growing seasons.While the interaction between silicone and Zolfast was significant, as cauliflower plants treated at the level of 1 $ml.L^{-1}$ silicon and 2.5 $ml.L^{-1}$ Zolfast were significantly excelled in the first season, reaching 5989 cm2 plant-1, compared to the lowest leaf area was 4592 cm^2 $plant^{-1}$. of the plants treated with the level 1.5 $ml.L^{-1}$ silicon and 3.5 $ml.L^{-1}$ Zolfast,In the second season, plants treated with the level of 1.5 $ml.L^{-1}$ silicon and 3.5 $ml.L^{-1}$ Zolfast were

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significantly excelled to 7927 cm ^{2} plant^{-1} compared to 6628 cm ^{2} plant^{-1} resulting from the control treatment for both factors.As for the triple interaction between the study factors, it was significant, as the plants of the first season treated with magnetized water, 1.5 ml.L^{-1} silicon and 0 ml.L^{-1} Zolfast gave the highest leaf area of 6430 cm^{2} plant^{-1} compared to 4475 cm^{2} plant^{-1} produced in Plants treated with non-magnetized water and 1 ml.L^{-1} silicone and 3.5 ml.L^{-1} Zolfast, In the second season, plants irrigated with magnetized water and treated with the level of 1.5 ml.L^{-1} silicon and 3.5 ml.L^{-1} Zolfast. It gave the highest leaf area of 8276 cm^{2} plant^{-1} compared to the lowest leaf area was 6451 cm^{2} plant^{-1} produced from plants irrigated with non-magnetized water that were not treated with both factors.

Table (3) Effect of water magnetization and spraying with Zolfast and silicon and their interactions on Leaf area (cm^{2}.plant^{-1})of cauliflower, cultivar Nahar

Magnetic water	Zolfast ml.L^{-1}	season (2018-2019) Silicon ml.L^{-1}			magnetization X Zolfast	season (2019-2020) Silicon ml.L^{-1}			magnetization X Zolfast
		0	1	1.5		0	1	1.5	
Magnetic	0	4504	4599	6430	5178	6804	7311	7718	7278
	2.5	4561	6329	6091	5660	7316	7682	8170	7723
	3.5	4739	4710	5911	5120	7635	7834	8276	7915
Without Magnetic	0	5242	5691	4633	5189	6451	6931	6632	6672
	2.5	5054	5649	4972	5225	6584	7098	7323	7002
	3.5	5628	4475	4757	4953	7015	7233	7578	7275
LSD 0.05		931.5			N.S	115.4			N.S
silicon		4955	5242	5466	Magnetic	6968	7348	7616	Magnetic
LSD 0.05		417.6				82.0			
magnetization X silicon	Magnetic	4601	5213	6144	5319	7252	7609	8055	7638
	Without Magnetic	5308	5272	4787	5122	6683	7087	7178	6983
LSD 0.05		731.0			N.S	99.0			71.4
					Zolfast				Zolfast
Zolfast X silicon	0	4873	5145	5531	5183	6628	7121	7175	6975
	2.5	4808	5989	5531	5443	6950	7390	7747	7362
	3.5	5183	4592	5334	5037	7325	7533	7927	7595
LSD 0.05		607.9			344.6	115.8			64.2

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Table (4) shows the effect of magnetization of water and spraying with zolfast and silicon and their interaction on the maturity time of the curds. It is noted that there is a significant effect of magnetization of water in this trait for both seasons, where the plants treated with magnetized water gave the highest number of days, 133.3 and 133.0 days, for the two seasons, respectively, compared with 126.2, 126.4 days respectively without magnetization. It is also noted that the level of 1.5 ml L^{-1} silicon was significantly excelled in the first season, which amounted to 131.9 days compared to the two levels,While the level of 1 ml.L^{-1} significantly excelled on the control treatment, which was 127.7 days, while in the second season, the level of 1.5 ml.L^{-1} reached 131.8 days compared to the levels 0 and 1 ml.L^{-1} silicon, which reached 128.1 and 129.1 days, respectively. The level of 3.5 ml.L^{-1} of Zolfast was significantly excelled in both seasons, which amounted to 133 and 131.8 days, respectively, compared to the other two levels, while the level of 2.5 ml.L^{-1} of Zolfast was significantly excelled on the control treatment, which was 127.7 and 127.3 days, respectively.As for the interaction between magnetization and Zolfast, the plants treated with magnetization and the level 3.5 ml.L^{-1} Zolfast significantly in the first season only amounted to 137 days compared to the control plants treated with non-magnetized water where it was 123.9 days, While it was not clear from the same table that the bi-interaction between the magnetizing factors and silicon was not significant in the first season, In the second season, plants treated with 1.5 ml.L^{-1} and irrigated with magnetized water significantly excelled for 134.4 days compared to the control treatment of plants treated with non-magnetized water, which was 124.1 days.As for the interaction of magnetization with Zolfast, the dual interaction between Silicon and Zolfast agents had a significant effect in the first season only, as the cauliflower plants treated at the level of 1 ml.L^{-1} silicon and 3.5 ml.L^{-1} Zolfast significantly excelled it for 134 days Compared to the control treatment for both factors, it was 123.7 days.

Table (5) shows the effect of water magnetization and spraying with zolfast and silicon and their interaction on the diameter of the curds for the two growing seasons. It is noted that there was no significant effect of water magnetization in this trait in the first season, while the plants treated with magnetized water significantly excelled in the second season, reaching 14.60 cm.plant^{-1} compared to the minimum diameter of the curds was 13.97 cm.plant^{-1} without magnetization. It is also noted that the level of 1.5 ml.L^{-1} of silicon was significantly excelled in the first season, which amounted to 14.25 cm.plant^{-1}, compared to the control treatment, which was 13.31 cm.plant^{-1},While the level of 1 ml.L^{-1} of silicon did not have a significant difference from the other two levels, while in the second season, the level of 1.5 ml.L^{-1} was significantly excelled, amounting to 14.72 cm.plant^{-1}, compared to the other two levels, while the level of 1 ml.L^{-1} was superior to the control treatment that gave the minimum curds diameter amounted to 13.95 cm.plant^{-1}.The levels of 2.5 and 3.5 ml.L^{-1} of Zolfast were significantly excelled in the first season, which amounted to 14.07 and 14.09 cm.plant^{-1}, respectively, compared to the control treatment, which was 13.08 cm.plant^{-1}, while in the second season, the level of 3.5 ml.L^{-1} was significantly excelled was 15.25 cm.plant^{-1} compared to the other two levels, while the level 2.5 ml.L^{-1} was excelled on the control treatment as it gave the lowest curds diameter was 13.12 cm plant-1, It is clear from the same table that the bi- interaction between magnetizing factors and silicon was significant in the first season only, where the plants treated with magnetized water and the level of 1.5 ml.L^{-1} silicon were significantly excelled 14.46 cm.plant^{-1}compared to plants treated with magnetized water that were not treated with silicon (control) 12.84 cm.plant^{-1},As for the interaction between magnetizing factors and Zolfast, it was significant in the first season only, as the plants treated with non-magnetized water and the level 3.5 ml.L^{-1} Zolfast were significantly excelled 14.40

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cm.plant^{-1}compared to the control plants treated with non-magnetized water, which gave the lowest curds diameter reached 12.40 cm.plant^{-1},

Table (4) Effect of water magnetization and spraying with Zolfast and silicon and their interactions on the maturity time of curd (day)of cauliflower, cultivar Nahar

Magnetic water	Zolfast ml.L^{-1}	season (2018-2019) Silicon ml.L^{-1}			magnetization X Zolfast	season (2019-2020) Silicon ml.L^{-1}			magnetization X Zolfast
		0	1	1.5		0	1	1.5	
Magnetic	0	126.3	126.7	132.3	128.4	128.7	130.0	132.0	130.2
	2.5	133.7	133.7	135.7	134.3	132.7	132.7	135.0	133.4
	3.5	136.7	137.3	137.0	137.0	134.7	134.7	136.3	135.2
Without Magnetic	0	121.0	123.7	127.0	123.9	122.0	124.3	126.7	124.3
	2.5	122.7	125.7	129.3	125.9	124.0	126.0	129.0	126.3
	3.5	126.0	130.7	130.0	128.9	126.3	127.0	132.0	128.4
LSD 0.05		N.S			2.49	N.S			N.S
silicon		127.7	129.6	131.9	Magnetic	128.1	129.1	131.8	Magnetic
LSD 0.05		1.76				1.16			
magnetization X silicon	Magnetic	132.2	132.6	135.0	133.3	132.0	132.4	134.4	133.0
	Without Magnetic	123.2	126.7	128.8	126.2	124.1	125.8	129.2	126.4
LSD 0.05		N.S			3.29	1.93			2.41
					Zolfast				Zolfast
Zolfast X silicon	0	123.7	125.2	129.7	126.2	125.3	127.2	129.3	127.3
	2.5	128.2	129.7	132.5	130.1	128.3	129.3	132.0	129.9
	3.5	131.3	134.0	133.5	132.9	130.5	130.8	134.2	131.8
LSD 0.05		2.26			1.15	N.S			0.80

ISSN 2072-387580

Table (5) Effect of water magnetization and spraying with Zolfast and silicon and their interactions on curd diameter (cm)of cauliflower, cultivar Nahar

Magnetic water	Zolfast ml.L^{-1}	season (2018-2019) Silicon ml.L^{-1}			magnetization X Zolfast	season (2019-2020) Silicon ml.L^{-1}			magnetization X Zolfast
		0	1	1.5		0	1	1.5	
Magnetic	0	12.66	13.41	15.23	13.77	13.06	13.43	14.23	13.57
	2.5	12.79	14.97	14.11	13.96	14.33	14.54	15.18	14.69
	3.5	13.08	14.22	14.03	13.78	15.61	15.29	15.71	15.53
Without Magnetic	0	12.39	11.12	13.67	12.40	12.16	13.06	12.85	12.69
	2.5	14.11	13.93	14.49	14.18	13.69	14.12	14.97	14.26
	3.5	14.86	14.38	13.96	14.40	14.86	14.65	15.39	14.97
LSD 0.05		N.S			0.92	N.S			N.S
silicon		13.31	13.67	14.25	Magnetic	13.95	14.18	14.72	Magnetic
LSD 0.05		0.53				0.46			
magnetization X silicon	Magnetic	12.84	14.20	14.46	13.83	14.33	14.42	15.04	14.60
	Without Magnetic	13.79	13.14	14.04	13.66	13.57	13.94	14.40	13.97
LSD 0.05		0.78			N.S	N.S			0.38
					Zolfast				Zolfast
Zolfast X silicon	0	12.53	12.27	14.45	13.08	12.61	13.24	13.54	13.13
	2.5	13.45	14.45	14.30	14.07	14.01	14.33	15.07	14.47
	3.5	13.97	14.30	13.99	14.09	15.23	14.97	15.55	15.25
LSD 0.05		1.01			0.66	N.S			0.37

Table (6) shows the effect of magnetization of water and spraying with Zolfast and silicon and their interaction on the weight of the average curds for the two growing seasons. It is noted that the plants treated with magnetized water were significantly excelled in the first season only, amounting to 500.2 g, compared to the lowest average weight of curds which was 461 g without magnetization.It is also noted that the levels 1 and 1.5 ml.L^{-1} silicon were significantly excelled in the first season, reaching 489.3 and 502.2 g, respectively, compared to the control treatment, which was 450.3 g. In the second season, levels 1 and 1.5 ml.L^{-1} of silicon were significantly excelled as they reached 569.8 and 567.1 g, respectively, compared with the control treatment, which was 503.9 g.The table shows that the level of 3.5 ml.L^{-1} of Zolfast was significantly excelled in the two seasons, reaching 575.1 and 602 gm, respectively, compared to the other two levels,

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while the level of 2.5 ml .L^{-1} showed significantly on the control treatment, which was 377.6 and 477.2 g, respectively.It is clear from the same table that the bi-interaction between magnetizing factors and silicon did not have a significant effect on this trait in both growing seasons. As for the interaction between magnetization and Zolfast, it is noted that the plants treated with magnetized water and the level 3.5 ml.L^{-1} Zolfast were significant in both seasons, reaching 595.0 and 634.0 g respectively, Compared with control plants treated with non-magnetized water, which were 374.8 and 456.6 g, respectively, as it turns out from the same table that the interaction between silicon and zolfast factors was significant in both seasons, as the plants treated with the level 1 ml.L^{-1}.Silicon and 3.5 ml.L^{-1} Zolfast excelled and gave in the first season 585.3 g compared to control plants for both factors 346.0 g, while in the second season the plants treated with 1.5 ml.L^{-1} Silicon and 3.5 ml.L^{-1} Zolfast reached 616.0 g compared to plants treated with 1.5 ml.L^{-1} Silicon and 3.5 ml.L^{-1} Zolfast The comparison for both factors was 434.3 g.As for the triple interaction between the study factors, it was significant in both seasons, where the plants treated with magnetized water, 1 ml.L^{-1} silicon and 3.5 ml.L^{-1} Zolfast gave the highest weight of curds reached 608.3 and 616.0 gm, in both seasons, respectively, compared to The lowest weight was 346.0 and 422.3 g, respectively, which resulted in the control treatment for both factors and without magnetization.It is clear from the same table that the bi-interaction between magnetizing factors and silicon did not have a significant effect on this trait in both growing seasons. As for the interaction between magnetization and Zolfast, it is noted that the plants treated with magnetized water and the level 3.5 ml.L^{-1} Zolfast were significant in both seasons, reaching 595.0 and 634.0 g respectively, Compared with control plants treated with non-magnetized water, which were 374.8 and 456.6 g, respectively, as it turns out from the same table that the interaction between silicon and zolfast factors was significant in both seasons, as the plants treated with the level 1 ml.L^{-1} .Silicon and 3.5 ml.L^{-1} Zolfast excelled and gave in the first season 585.3 gm compared to control plants for both factors 346.0 g, while in the second season the plants treated with 1.5 ml L^{-1} Silicon and 3.5 ml.L^{-1} Zolfast reached 616.0 g compared to plants treated with 1.5 ml L^{-1} Silicon and 3.5 ml.L^{-1} Zolfast The control for both factors was 434.3 g.As for the triple interaction between the study factors, it was significant in both seasons, where the plants treated with magnetized water, 1 ml L^{-1} silicon and 3.5 ml L^{-1} Zolfast gave the highest weight of curds reached 608.3 and 616.0 g, in both seasons, respectively, compared to The lowest weight was 346.0 and 422.3 g, respectively, which resulted in the control treatment for both factors and without magnetization.

Table (7) shows the effect of water magnetization of and spraying with zolfast and silicon and their interaction on the total yield of the two growing seasons. It is noticed that the plants treated with magnetized water were significantly excelled in the first season only, amounting to 14.67 tons.ha^{-1} compared to 13.52 tons.ha^{-1} without magnetization.It is also noted that the levels 1 and 1.5 ml L^{-1} of silicon were significantly excelled in the first season, amounting to 14.35 and 14.73 tons.ha^{-1}, respectively, compared to the control treatment was 13.21 tons.ha^{-1}. In the second season, levels 1 and 1.5 ml.L^{-1} was significantly excelled, reaching 16.71 and 16.64 tons.ha^{-1}, respectively compared with the control treatment, which amounted to 14.78 tons.ha^{-1}. Also, the level of 3.5 ml L^{-1} of Zolfast was significantly higher in the first season, amounting to 16.87 tons.ha^{-1} compared to the other two levels.While the level of 2.5 ml L^{-1} excelled on the control treatment, which was 11.08 tons ha-1, while in the second season, the level of 3.5 ml L^{-1} was significantly excelled to 17.66 tons.ha^{-1} compared to the other two levels, while the level of 2.5 ml L^{-1} was excelled compared to the control treatment which was 14 tons.ha^{-1}.Table (7) shows the effect of water magnetization of and spraying with zolfast and

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silicon and their interaction on the total yield of the two growing seasons. It is noticed that the plants treated with magnetized water were significantly excelled in the first season only, amounting to 14.67 tons.ha^{-1} compared to 13.52 tons.ha^{-1} without magnetization.It is also noted that the levels 1 and 1.5 ml.L^{-1} of silicon were significantly excelled in the first season, amounting to 14.35 and 14.73 tons.ha^{-1}, respectively, compared to the control treatment was 13.21 tons.ha^{-1},In the second season, levels 1 and 1.5 ml.L^{-1} was significantly excelled, reaching 16.71 and 16.64 tons.ha^{-1}, respectively compared with the control treatment, which amounted to 14.78 tons.ha^{-1}. Also, the level of 3.5 ml.L^{-1} of Zolfast was significantly higher in the first season, amounting to 16.87 tons.ha^{-1} compared to the other two levels.While the level of 2.5 ml.L^{-1} excelled on the control treatment, which was 11.08 tons ha-1, while in the second season, the level of 3.5 ml L^{-1} was significantly excelled to 17.66 tons / ha-1 compared to the other two levels, while the level of 2.5 ml.L^{-1} was excelled compared to the control treatment which was 14 tons.ha^{-1}.The table shows that the binary interaction between magnetizing agents and silicon was not significant in both seasons, while the bi-interaction between magnetizing factors and Zolfast, the plants treated with magnetized water and 3.5 ml.L^{-1} Zolfast were significantly excelled in both seasons, amounting to 17.45 and 18.60 tons.ha^{-1}, respectively, compared with 10.99, 13.39 tons.ha^{-1}, in both seasons, respectively, resulted in the control treatment of plants without magnetization, It also appears from the same table that the interaction between the two factors silicone and Zolfast was significant in both seasons, as the plants treated with the level of 1 ml.L^{-1} silicone and 3.5 ml.L^{-1} Zolfast excelled a17.17 tons.ha^{-1} in the first season compared to the control plants for both factors were 10.15 In the second season, the plants treated with 1.5 ml.L^{-1} silicon and 3.5 ml.L^{-1} Zolfast were superior to 18.07 tons.ha^{-1} compared to the control plants for both factors were 12.74 tons.ha^{-1}.The triple interaction between the study factors was significant in both seasons, where the plants treated with magnetized water, 1 ml.L^{-1} silicon and 3.5 ml.L^{-1} Zolfast gave the highest total yield of 17.84 and 19.13 tons.ha^{-1}, in both seasons, respectively. , compared to the lowest total yield was 9.93, 12.39 tons.ha^{-1}, respectively, resulted in the control treatment for both factors and without magnetization.

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Table (6) Effect of water magnetization and spraying with Zolfast and silicon and their interactions on weight of curd (g)of cauliflower, cultivar Nahar

Magnetic water	Zolfast ml.L^{-1}	season (2018-2019) Silicon ml.L^{-1}			magnetization X Zolfast	season (2019-2020) Silicon ml.L^{-1}			magnetization X Zolfast
		0	1	1.5		0	1	1.5	
Magnetic	0	353.3	385.7	402.3	380.4	446.0	532.7	514.7	497.8
	2.5	459.3	550.0	566.0	525.1	496.3	603.7	624.7	574.9
	3.5	577.7	608.3	599.0	595.0	603.0	652.3	646.7	634.0
Without Magnetic	0	338.7	389.7	396.0	374.8	422.3	492.3	455.0	456.6
	2.5	430.3	440.0	489.3	453.2	510.0	559.0	576.3	548.4
	3.5	542.7	562.3	560.3	555.1	545.7	579.0	585.3	570.0
LSD 0.05		46.11			25.52	76.85			60.16
silicon		450.3	489.3	502.2	Magnetic	503.9	569.8	567.1	Magnetic
LSD 0.05		24.46				48.17			
magnetization X silicon	Magnetic	463.4	514.7	522.4	500.2	515.1	596.2	595.3	568.9
	Without Magnetic	437.2	464.0	481.9	461.0	492.7	543.4	538.9	525.0
LSD 0.05		N.S			26.72	N.S			N.S
					Zolfast				Zolfast
Zolfast X silicon	0	346.0	387.7	399.2	377.6	434.2	512.5	484.8	477.2
	2.5	444.8	495.0	527.7	489.2	503.2	581.3	600.5	561.7
	3.5	560.2	585.3	579.8	575.1	574.3	615.7	616.0	602.0
LSD 0.05		33.97			18.61	53.74			21.03

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Table (7) Effect of water magnetization and spraying with Zolfast and silicon and their interactions on total yield (ton.ha^{-1})of cauliflower, cultivar Nahar

Magnetic water	Zolfast ml.L^{-1}	season (2018-2019) Silicon ml.L^{-1} 0	1	1.5	magnetization X Zolfast	season (2019-2020) Silicon ml.L^{-1} 0	1	1.5	magnetization X Zolfast
Magnetic	0	10.36	11.31	11.80	11.16	13.08	15.62	15.10	14.60
	2.5	13.47	16.13	16.60	15.40	14.56	17.71	18.32	16.86
	3.5	16.94	17.84	17.57	17.45	17.69	19.13	18.97	18.60
Without Magnetic	0	9.93	11.43	11.62	10.99	12.39	14.44	13.35	13.39
	2.5	12.62	12.91	14.35	13.29	14.96	16.40	16.91	16.09
	3.5	15.92	16.49	16.44	16.28	16.01	16.98	17.17	16.72
LSD 0.05		1.35			0.75	2.25			1.77
silicon		14.78	16.71	16.64	Magnetic	13.21	14.35	14.73	Magnetic
LSD 0.05		1.41				0.72			
magnetization X silicon	Magnetic	13.59	15.10	15.32	14.67	15.11	17.49	17.46	16.69
	Without Magnetic	12.83	13.61	14.14	13.52	14.45	15.94	15.81	15.40
LSD 0.05		N.S			0.78	N.S			N.S
					Zolfast				Zolfast
Zolfast X silicon	0	10.15	11.37	11.71	11.08	12.74	15.03	14.22	14.00
	2.5	13.05	14.52	15.48	14.35	14.76	17.05	17.61	16.48
	3.5	16.43	17.17	17.00	16.87	16.85	18.06	18.07	17.66
LSD 0.05		1.00			0.55	1.58			0.62

The increase in vegetative traits when treating cauliflower plants with magnetized water may be due to the role of this type of water in the availability of nutrients in the soil in addition to the efficiency of transporting these elements and their absorption by the roots (30), as well as working to reduce the surface tension of water and thus the entry of its molecules through the cell walls, working on the speed of their division and elongation.(34), which helped in increasing the plant height and that the increase in the number of leaves may be due to the vital effects caused by magnetized water inside plant tissues and organs as a result of increasing the water's ability to dissolve salts and decreasing soil pH, as well as increasing the speed of chemical reactions in plant tissues (22), and thus increasing the

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number of leaves in the plant (19).The magnetizing factor has a role in facilitating the passage of water molecules through the cell membrane in addition to the nutrients absorbed by the plant, which is positively reflected in the process of photosynthesis (30), which led to an increase in the leaf area of the plant. The increase in the maturity date of the curds may be due to the effective effect of magnetization in reducing the percentage of sodium and reducing the salt stress of the plant through salt washing and increasing the availability of nutrients (26).This result agreed with the findings of (9) as treatment of aster plants with magnetically treated water delayed flowering compared to plants irrigated with non-magnetized water. The magnetization has a role in breaking the hydrogen bonds in saltwater, which helps in washing the soil and helping the plant to absorb water and nutrients easily from the soil (4).The increase in the average weight of the curds due to the influence of the magnetization factor of the irrigation water was reflected on the total yield. This conclusion was reached by (38); (14); (1) On a cucumber plant. It was noted that cauliflower yield decreased significantly due to non-magnetized water stress (42; 21).Treating plants with silicon affects the reduction of salinity damage resulting from irrigation with saline well water, which causes salt stress, as it increases the vital activities of plant cells.This is reflected in the materials and compounds resulting from the photosynthesis process, and thus an increase in plant growth and improvement of vegetative growth traits (18).As it has a role in increasing the absorption of water and nutrients, thus accelerating the process of growth and discovery (23) and increasing the number of leaves and leaf area. The positive effect of this increase may be due to the increased water content of the plant (37),In addition to its important role in improving the effectiveness of photosynthesis and the synthesis of organelles in the plant leaf (39), increasing the efficiency of roots in absorbing water and nutrients, which is positively reflected on the traits of the yield 40)). The increase in the amount of yield as a result of treatment with silicon is due to its role in improving the traits of vegetative growth, such as the number of leaves and leaf area (Table 2 and 3) of the plant before reaching the stage of yield formation, and this is consistent with (28) on tomato and (6) on eggplant. The increase in vegetative traits may be due to the important role of sulfur in encouraging cell elongation and division, where it is one of the components of amino acids such as cystine and methionine and some vitamins such as thyamine and biotin. They are essential in the synthesis of auxins (2; 12; 16). which helped increase the height of the plant and that the increase in the number of leaves and leaf area may be due to the vital role that sulfate plays in the formation of energy transfer compounds and the activation of a number of enzymes involved in this process. From the case of competition between the parts of one plant, it provides a better stage for the growth and expansion of the leaf area (17).The positive changes in the vegetative growth of cauliflower when treated with Zolfast in addition to the increase in the chlorophyll content in the leaves helped in increasing the activity of photosynthesis processes in the leaves and the transfer of a large part of its products to the active growth areas and storage of some of them (41), and this encouraged the formation of a larger number of the flower buds in curds and the increase in the diameter and weight of curds,This may be due to the availability of sulfur and the increase in its concentration inside the plant, and this plays an important role in increasing the amount of carbohydrates in the leaves and their transfer to the curds, thus increasing their weight (12) and (2). These results agree with what he found (27; (11) on tomato, (31) on onions and thyme, and (3)) on okra.

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