THE COMBINED EFFECT OF BIO-STIMULANTS ON THE FLOWER GROWTH, YIELD, AND ESSENTIAL OIL CHARACTERISTIC OF CUMIN

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ABSTRACT

This study was conducted during two winter seasons 2020-2019 and 2021-2020 at the College of Agricultural Engineering Sciences-University of Baghdad (Al-Jadriya). To improve the efficiency and productivity of the flower growth, yield, and essential oil characteristic of cumin (*Cuminum cyminum* L.). The experiment included two-factors, the first with four levels of bio-fertilizers (without vaccination, *Pseudomonas fluorescens*, *Azospirillum brasilense*, and mixture between vaccination), while the second with a combination of five levels that included two treatments (15 and 30 ml L^{-1}) for each of coconut endosperm fluid and tryptophan with one metering treatment for both (sprayed with distilled water). Randomized complete block design (RCBD) was used in a spilt-plot design with three replications. The results showed that all studied traits were affected by the study factors for both seasons, as the plants treated with the spray combination (30 ml L^{-1} each) with mixture between vaccination gave superiority in most of the within, and the interaction effect between the study factors was significant compared to the plants uninoculated and unsprayed for both seasons.

Keywords: coconut endosperm fluid, cuminaldehyde, tryptophan, GC-MS, zeatin, sustainability.

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التأثير المشترك للمحفزات الحيوية في صفات النمو الزهري والمادة الفعّالة لنبات الكمون

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المستخلص

نفذت الدراسة حقلياً خلال الموسمين الشتويين (2020–2019) و (2021–2020) في حقل تجارب كلية علوم الهندسة الزراعية – جامعة بغداد (الجادرية)، بهدف تحسين كفاءة وإنتاجية صفات النمو الزهري والحاصل والمادة الفعالة لنبات الكمون (*Cuminum cyminum* L.). تضمنت التجربة دراسة عاملين، الاول بأربعة مستويات من المخصبات الاحيائية (بدون تلويث و *Pseudomonas fluorescens* و *Azospirillum brasilense* والخليط بين المخصبين)، والثاني توليفة من خمس مستويات شملت معاملتين (15 و 30 مل لتر$^{-1}$) لكل من السائل الاندوسبيرمي لجوز الهند والتربتوفان مع معاملة القياس واحدة لكليهما (الرش بالماء المقطر فقط). نفذت التجربة وفق تصميم القطاعات العشوائية الكاملة بترتيب الالواح المنشقة وبثلاث مكررات. أظهرت نتائج الدراسة ان النباتات المعاملة بتوليفة الرش (30 مل لتر$^{-1}$ لكل منهما) بوجود الخليط الاحيائي بين المخصبين تفوقت معنوياً في جميع الصفات المدروسة قياساً بالنباتات غير الملوثة وغير المرشوشة لكلا الموسمين.

الكلمات المفتاحية: المخصبات الاحيائية، السائل الاندوسبيرمي لجوز الهند، التربتوفان، الزيت العطري، الزياتين، استدامة

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INTRODUCTION

Cumin (*Cuminum cyminum* L.), an herbal plant belonging to the Apiaceae family, is one of the ten most widely used plants in the world for its medicinal and nutritional importance because its seeds contain many effective chemical compounds, including essential oils, which are used in many pharmaceutical, food and cosmetic industries (30). Several studies have shown that its seeds oil has anti-microbial, anti-inflammatory and analgesic, anti-oxidant, anti-cancer, and anti-diabetic effects, as well as supporting the body's immune system (9). The characteristics of floral growth and yield are considered the important qualitative indicators in determining the seeds yield of apiaceae family species (6), both quantitatively and qualitatively, as it is the main objective in the production of cumin group. The aromatic oils in cumin seeds are one of the main components that are attributed to the medicinal aspect because it contains many secondary metabolites and active biological substances of medical and pharmaceutical importance (13). Bio-fertilizers are one of the most important agricultural technologies that have recently used by agricultural field, and today it has become one of the most important environmentally safe and inexpensive agricultural means for farmers (22). *Azospirillum brasilense* is characterized by its high ability to fix atmospheric nitrogen and to produce growth-stimulating materials (29). *Pseudomonas fluorescens* increases the availability of phosphorous in the soil as a result of its secretion of the phosphatase enzyme and its production of organic acids (33), and the above fertilizers also participate in the secretion of many growth regulators such as Auxin, Gibberellin and Cytokinin, which is positively reflected in all growth parameters as well as stimulating plant growth and increasing its productivity. It was indicated by El-Hadi et al (14) that plants contaminated with their seeds with the bio-fertilizers mixture, including *Azospirillum brasilense*, led to a significant increases in plant height, total chlorophyll, fresh and dry weight of the vegetative total of coriander plants compared to the uncontaminated plants for both seasons. Likewise, when polluting the seeds of the sweet bean plant with bio-fertilizer, Pseudomonas fluorescens, it increased significantly in some indicators of vegetative growth, including dry weight, compared to the uncontaminated plants (11). In last few decades; researchers have been utilizing plant based materials to insure sustainability and clean food Spraying (4, 5,). coconut endosperm fluid is one of the compounds similar to cytokines and one of the most important natural plant hormones isolated from coconut fruits and it constitutes more than 20% of the activity of total cytokinin's that have an active role in physiological processes within the plant tissues (32). The amino acid tryptophan is also one of the amino acids that activate the formation of natural auxins and has a significant role in stimulating and stimulating root growth in plants, and it is one of the most efficient physiological initiators and the main source of IAA in most organisms (31, 12). This study was aimed to use nutrients represented by biological fertilizers and the combination of spraying consisting of bio-stimulants represented by (coconut endosperm fluid) and the vital growth cumin group enhancers represented by (amino acid tryptophan), for the purpose of determining the best studied treatments and in appropriate quantities to improve the efficiency and productivity of flowering growth, yield and chemical composition of essential oils of Cumin seeds.

MATERIAIS AND METHODS

A field experiment was conducted at the experiment field, of the College of Agricultural Engineering Sciences - University of Baghdad (Al-Jadriya) during the two winter seasons 2019-2020 and 2020-2021 consecutively on the cumin plant (*Cuminum cyminum* L.) (Turkish variety) under the influence of Iraqi conditions by studying its response to the interaction effect of bio-fertilizers, coconut endosperm fluid and the amino acid tryptophan (24). The experiment was applied in order of split panels according to a randomized complete block design (RCBD) with in split plot arrangement using three replications. The experiment included a study two factors, the first factor occupied the main plates of four treatments that included contaminating the seeds with bio-fertilizers (without vaccination, *Azospirillum brasilense*, *Pseudomonas fluorescens* and a mixture between vaccination) which symbolized by (A0, A1, A2 and A3), while the second factor was occupied the sub plot included two treatments at level (15 and 30 ml L^{-1}) for each of the coconut endosperm fluid with the same treatments for Tryptophan amino acid with one measurement for both (spraying with distilled water only) which symbolized by (B0C0, B15C15, B15C30, B30C15 and B30C30). It was sprayed on the vegetative system in three stages, the first after a month of polluting the seeds with bio-fertilizer and cultivation, while the second stage after a month from the first spray in the stage of emergence and formation of branches, while the third stage when the beginning of the emergence of flower buds. Soil service operations were carried out, including plowing, smoothing and leveling, and then the experimental field was divided into experimental units, which numbered 60 (4 x 5 x 3 = 60) experimental units. (7) rows, the distance between rows (50 cm) and the distance between one experimental unit and another (1 m) and between one repeater and another (2 m). Cumin seeds were sown in a swarm in lines with a seeds quantity of 15 kg ha-1 and a depth of 2-3 cm, on November 1, 2020 and 2021 for both seasons. The field soil was also fertilized with half of the approved fertilizer recommendation, as the full fertilizer recommendation included adding phosphate fertilizer in the form of triple superphosphate (52% P2O5) at a rate of 60 kg ha^{-1} scattered before planting; Then nitrogen fertilizer was added in the form of urea (46% N) in two batches of 90 kg ha^{-1}, the first after thinning of the plants and the second after the emergence of more than (50%) of flower buds as a booster dose (7). The crop service operations of irrigation, hoeing and weeding were applied whenever needed. The plants were harvested between 10-15 April 2020 and 2021 for both seasons sequentially, after signs of fruit maturity appeared on the plants and their coloration was olive-yellow in anticipation of seeds drop and before complete drought. The studied data were statistically analyzed according to the GenStat program (Release 12.1) according to the design using analysis of variance, the means of the treatments were compared on using L.S.D. test with a significant 5%.

Extraction of Essential Oil and Its Analysis

The essential oil was extracted from the seeds of the cumin plant by grinding 50 g of seeds and adding to it 500 ml of distilled water by hydro-distillation method using a Clevenger device, followed by storing at 4°C according to the method used (18). The Essential Oil components are analyzed by Gas Chromatography-Mass Spectroscopy (GC-MS), according to the method (34). And were then identified by compart them with the Mass Spectra found in the library in the NIST standard source database (27).

RESULTS AND DISCUSSION

Number of days from planting to 75% flowering: The data in Table 1 indicates that there was a significant effects between bio-fertilizers in the number of days from planting to 75% flowering of the plants compared to plants A0 (without adding vaccine), as it took the contaminated plants A3 seeds less days to reach 75% flowering amount 129.61 and 130.32 days, respectively, compared to A0 plants, which took more days to reach this stage, with amount 151.06 and 153.13 days for both seasons, respectively. While it took the contaminated plants A2 and A1 more days to reach this stage, it was needed 136.50 and 142.65 days and 136.46 and 144.43 days for both seasons, respectively. The above results also showed that the plants treated with the coconut endosperm fluid and tryptophan were significantly affected in the number of days from planting to 75% flowering of the plants, when plants treated B30C30 reached this stage with fewer days of 144.23 and 146.40 days than the B0C0 plants (spraying with distilled water only) for both seasons sequentially, while the treated plants B30C15 and B15C30 reached this stage with 145.18 and 147.23 days and 148.52 and 149.33 days for both seasons sequentially; Whereas, the B15C15-treated plants were late in reaching this stage, as it took 149.12 and 151.25 days, compared to the previous treated plants, for both seasons sequentially. Regarding the interaction effect between the study factors, the results showed in the same table that there were significant differences between them in the characteristics of the number of days from planting until flowering 75% of the plants, as the contaminated plants A3 and sprayed B30C30 took 120.57 and 122.09 days less compared to plants A0B0C0 for both seasons sequentially. Also, the sprayed plants B30C30 in the presence of A2 took 130.59 and 131.44 days less days compared to the non-sprayed plants that achieved more days to reach this trait, which amounted to 136.50 and 136.46 days for both seasons, respectively. While the sprayed plants B30C30 in the presence of A1 compared to the contaminated and non-sprayed plants took 138.61 and 138.32 days compared to the contaminated and non-sprayed plants that achieved more days to reach this trait amounted to 142.65 and 144.43 days for both seasons, respectively. Also reveals from the same Table that there are significant differences in the number of days up to this stage between the sprayed plants B15C15, B15C30 and B30C15, according to the difference of bio-fertilizers compared to the plants A0B0C0 for both seasons respectively**.**

Number of flowering inflorescences per plant (inflorescence plant^{-1}); The results in Table 1 show, that plants contaminated with seeds A3 recorded a remarkable progress in the number of inflorescences with an increases 285.94 and 118.06% over A0 for both seasons sequentially.

Table 1. Combined effect of Bio-Stimulants on Number of days from planting to 75% flowering and Number of flowering inflorescences per plant (inflorescence plant^{-1}) for both seasons

Biofertilizer	Season 2019-2020 Spraying treatment B.C. (ml L^{-1})					Means (A)	Season 2020-2021 Spraying treatment B.C. (ml L^{-1})					Means (A)
(A)	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$		B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	
A0	151.06	149.12	147.23	145.18	144.23	147.36	153.13	151.25	149.33	148.52	146.40	149.73
A1	142.65	141.46	140.56	139.50	138.61	140.56	144.43	143.39	142.21	141.22	140.32	142.31
A2	136.50	135.25	133.37	131.50	130.59	133.44	138.37	137.91	135.82	133.12	132.44	135.53
A3	129.61	127.53	125.44	122.70	120.57	125.17	131.32	129.59	127.62	124.24	122.09	126.97
$LSD_{A*B.C}$			1.255			1.106			1.31			1.10
Means B.C.	139.96	138.34	136.65	134.72	133.50		141.81	140.54	138.75	136.78	135.31	
$LSD_{B.C}$			0.436						0.40			
Number of flowering inflorescences per plant (inflorescence plant^{-1}) for both seasons												
Biofertilizer (A)	Season 2019-2020 Spraying treatment B.C. (ml L^{-1})					Means (A)	Season 2020-2021 Spraying treatment B.C. (ml L^{-1})					Means (A)
	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$		B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	
A0	13.44	15.35	17.41	20.25	23.21	17.93	19.32	21.54	23.35	25.28	27.31	23.36
A1	25.35	27.44	29.57	32.38	34.54	29.86	30.68	32.65	33.25	35.59	37.32	33.90
A2	35.23	36.81	37.84	39.31	40.78	38.85	36.56	37.89	38.43	40.90	41.49	37.99
A3	41.87	42.46	44.20	46.86	48.92	46.47	43.13	45.25	46.61	47.42	49.92	44.86
$LSD_{A*B.C}$			1.279			1.038			1.70			1.40
Means B.C.	29.37	31.48	33.01	35.24	37.29		31.78	33.37	34.66	36.76	38.58	
$LSD_{B.C}$			0.509						0.70			

while plants contaminated with seeds of both A2 and A1 achieved an increases 191.89 and 110.94%, 84.06 and 58.80% for A0 plants for both seasons, respectively. It is clear from the same Table that spraying with coconut endosperm fluid and tryptophan had a significant effects on the number of flowering inflorescences per plant, as B30C30 treated plants recorded an increases 102.46 and 46.53% over B0C0 plants (spraying with distilled water only) for both seasons sequentially, while the treated plants with B30C15 and B15C30 increased by 80.43, 59.30%, 30.85 and 20.86% for the non-sprayed plants for both seasons, respectively, while the B15C15 treated plants recorded a decreases of 39.91 and 23.91% for the B30C30 treated plants for both seasons, respectively. Regarding the interaction effect between the study factors, it was show from the results of the same Table, that there were significant differences in the number of flowering inflorescences according to the different spraying factors in the presence of bio-fertilizers. sequentially. While the sprayed plants B30C30 in the presence of A1 and A2 gave significant differences from the plants polluted with both of them and the non-sprayed plants, an increases 35.94, 26.89%, 18.38 and 16.68% for both seasons, respectively. It was revealed from the same Table that there are significant differences in this trait between the sprayed plants B15C15, B15C30 and B30C15 by the differences of bio-fertilizers compared to the plants A0B0C0 for both seasons, respectively.

Number of flowers in the main inflorescence (flower inflorescence^{-1}): Results in Table 2 show, that plants contaminated with seeds A3 outperformed in the number of flowers in the main inflorescence by an increases 173.67 and 162.43% than A0 (without adding vaccine) for both seasons sequentially, followed by plants contaminated with seeds of both A2 and A1 with an increase 114.26, 73.50%, 132.13 and 95.35% for A0 plants for both seasons, respectively.

Table 2. Combined effect of Bio-Stimulants on the number of flowers in the main inflorescence (flower inflorescence^{-1}) for both seasons

Bio-fertilizer (A)	Season 2019-2020 Spraying treatment B.C. (ml L^{-1})					Means A.
	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	
A0	14.66	15.92	17.25	18.59	20.85	19.13
A1	21.45	22.11	24.15	25.89	26.94	26.64
A2	25.41	27.08	29.38	30.94	32.15	34.80
A3	31.12	33.35	36.36	37.74	39.72	44.60
LSD $_{A*B.C}$			1.772			0.586
Means B.C.	27.66	29.20	31.51	33.08	35.00	
LSD $_{B.C}$			0.957			
Bio-fertilizer (A)	**Season 2020-2021 Spraying treatment B.C. (ml L^{-1})**					**Means A.**
	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	
A0	16.28	17.72	18.66	20.64	21.61	18.98
A1	22.85	24.56	26.64	27.80	29.19	26.21
A2	30.47	32.75	34.20	35.89	37.07	34.08
A3	38.10	38.83	40.35	41.66	43.47	40.48
LSD $_{A*B.C}$			1.703			0.994
Means B.C.	26.93	28.47	29.96	31.50	32.84	
LSD $_{B.C}$			0.837			

From the results of the same table, it was observed that spraying with coconut endosperm fluid and tryptophan had a significant effects on the number of flowers in the main inflorescence, as the treated plants B30C30 recorded an increases 62.69 and 67.60% compared to B0C0 plants (spraying with distilled water only) for both seasons sequentially, while the plants recorded Treatment B30C15 and B15C30 increased by 54.09, 38.13%, 54.71 and 35.21% than B0C0 plants for both seasons respectively, while B15C15 treated plants recorded a decrease of 29.06 and 26.90% for B30C30 plants for both seasons respectively. About the interaction effect between the factors of the study, as the sprayed plants B30C30 in the presence of A3 achieved an increase in the number of flowers in the main inflorescence of 239.15 and 230.30% than the plants A0B0C0 for both seasons respectively. Followed by the sprayed plants B30C30 in the presences of each of A2 and A1, which achieved significant differences from the plants polluted with both of them and not sprayed with an increases 24.64, 17.64%, 10.15 and 17.89% for both seasons, respectively. It was reveals from the same Table that there are significant differences in this trait between the sprayed plants B15C15, B15C30 and B30C15 with different bio-fertilizers compared to A0B0C0 plants for both seasons, respectively.

Percentage of knots (%)

The results in Table 3 show, that the percentage of knots in plants was significantly affected by the different bio-fertilizers, as the polluted plants gave A3 seeds the highest contraction rate of 83.35 and 87.38% than the A0 plants for both seasons sequentially, while the polluted plants gave with each of A2 and A1 for the contraction percentage 80.73, 85.84%, 71.91 and 82.74% for both seasons, respectively, compared to A0 plants, which gave 65.87 and 66.57% for both seasons, respectively.

Table 3. Combined effect of Bio-Stimulants on the Percentage of knots (%) for both seasons

Bio-fertilizer (A)	Season 2019-2020 Spraying treatment B.C. (ml L^{-1})					Means A.
	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	
A0	65.87	66.82	68.49	70.23	71.53	68.59
A1	71.91	73.91	76.42	77.99	79.97	76.04
A2	80.73	81.89	83.40	85.35	87.75	83.82
A3	83.35	87.98	89.35	90.05	90.61	88.27
$LSD_{A*B.C}$			1.003			0.646
Means B.C.	75.46	77.65	79.41	80.90	82.46	
$LSD_{B.C}$			0.474			
Bio-fertilizer (A)	**Season 2020-2021 Spraying treatment B.C. (ml L^{-1})**					**Means A.**
	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	
A0	66.57	72.16	74.95	78.23	79.98	74.37
A1	82.74	83.89	84.36	85.28	85.70	84.39
A2	85.84	85.70	86.10	86.48	87.17	86.26
A3	87.38	87.90	88.89	89.58	91.00	88.95
$LSD_{A*B.C}$			1.304			1.166
Means B.C.	80.63	82.41	83.57	84.89	85.96	
$LSD_{B.C}$			0.438			

The results in the same Table show, spraying with the endosperm liquid of coconut and tryptophan had a clear role in this trait, as the plants treated B30C30 gave the highest percentage of the contract amounting to 71.53 and 79.98% than the B0C0 plants (spraying with distilled water only) for both seasons and sequentially. Whereas, the treated plants B30C15 and B15C30 gave a percentage of the contract amounted to 70.23, 68.49%, 78.23 and 74.95% of the plants B0C0 for both seasons in sequence, while the plants treated B15C15 gave the percentage of the decade 66.82 and 72.16% of the plants treated B30C30 for both seasons sequentially. Regarding the interaction effect between the study factors, it was noted that the sprayed plants B30C30 in the presence of A3 gave the highest percentage of the contract amounting to 90.61 and 90.00% than the plants A0B0C0 for both seasons sequentially. While the sprayed plants B30C30 in the presence of each of A2 and A1 gave significant differences from the plants polluted with each of them and the non-sprayed plants for the percentage of nodes 87.75, 79.97%, 87.17 and 85.70% for both seasons, respectively. It was show from same Table that there are significant differences in this trait between the sprayed plants B15C15, B15C30 and B30C15 by the difference of bio-fertilizers compared to the A0B0C0 plants for both seasons, respectively**.**

Number of days from sowing to full maturity (day): The results in Table 4 show, that there was a significant difference between the bio-fertilizers in the number of days from sowing to full maturity. The A0 (without adding vaccine), took the contaminated plants A3 less days to reach full maturity, which 160.43 and 157.67 days, respectively, compared to A0 plants, which took a greater number of days to reach this stage (180.12 and 179.09) days for both seasons, respectively. While the plants contaminated with both A2 and A1 took more days to reach full maturity, they reached 168.61 and 174.75 days and 165.10 and 173.55 days for both seasons, respectively. It was found from the results of the study in the same Table, that the combination of the endospermic fluid of coconut and tryptophan had a significant effect on the number of days from planting to full maturity, as it took B30C30 treated plants less number of days to reach this stage, which amounted to 175.41 and 174.12 days compared to B0C0 plants (spraying with distilled water only) for both seasons sequentially, while the sprayed plants with B15C30 and B30C15 did not move away from each other in taking more days to reach this stage for both seasons sequentially. While the plants sprayed with B15C15 achieved a significant increases over the plants treated with B30C30, with the highest number of days being 179.46 and 177.45 days for both seasons, respectively. Regarding the interaction effect between the study factors, it was noted from the results of the statistical analysis in the same Table that there was no significant effects for them on the number of days from planting to full maturity for both seasons.

Seeds number per the main inflorescence (seeds inflorescence^{-1}): The results in Table 4 show, that plants contaminated with seeds A3 had a significant increases 261.70 and 225.35% over A0 (without adding vaccine) for both seasons sequentially, while plants whose seeds were contaminated with both A2 and A1 achieved an increases 225.16 and 163.46% and 226.91 and 175.12% for plants A0 for both seasons, respectively.

Table 4. Combined effect of Bio-Stimulants on the number of days from planting to full maturity (day) and Seeds number per the main inflorescence (seeds inflorescence^{-1}) for both seasons

Biofertilizer (A)	Season 2019-2020 Spraying treatment B.C. (ml L^{-1})					Means (A)	Season 2020-2021 Spraying treatment B.C. (ml L^{-1})					Means (A)
	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$		B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	
A0	180.12	179.46	178.90	177.17	175.41	178.21	179.09	177.45	175.58	174.55	174.12	176.16
A1	174.75	172.58	171.56	170.95	169.45	171.86	173.55	171.72	170.36	168.30	166.18	170.02
A2	168.61	166.38	164.99	163.71	161.15	164.97	165.10	163.37	161.37	160.22	158.37	161.69
A3	160.43	159.15	157.16	155.87	153.65	157.25	157.67	156.77	154.72	153.22	150.92	154.66
$LSD_{A*B.C}$			N.S			0.942			N.S			0.84
Means B.C.	170.98	169.39	168.15	166.92	164.92		168.86	167.33	165.51	164.07	162.40	
$LSD_{B.C}$			1.141						1.02			

Seeds number per the main inflorescence (seeds inflorescence^{-1}) for both seasons

Biofertilizer (A)	Season 2019-2020 Spraying treatment B.C. (ml L^{-1})					Means (A)	Season 2020-2021 Spraying treatment B.C. (ml L^{-1})					Means (A)
	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$		B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	
A0	9.66	11.31	13.76	15.45	16.44	13.32	10.85	13.06	15.01	18.16	20.28	15.47
A1	17.97	19.13	19.85	21.32	23.16	20.29	24.90	26.60	27.48	29.72	30.02	27.74
A2	25.03	27.03	29.19	30.73	33.83	29.16	30.16	30.67	31.95	32.44	34.01	31.85
A3	34.94	36.95	40.21	42.32	44.4	39.76	35.69	36.54	40.86	43.32	45.16	40.31
$LSD_{A*B.C}$			1.50			1.37			1.5			1.1
Means B.C.	21.90	23.61	25.75	27.46	29.46		25.40	26.72	28.83	30.91	32.37	
$LSD_{B.C}$			0.48						0.7			

The combination of spraying with coconut endospermic liquid and tryptophan significantly affected the number of seeds in the main inflorescence, as the treated plants B30C30 had an increases 70.19 and 91.68% compared to the B0C0 plants (spraying with distilled water only) for both seasons sequentially, while the treated plants B30C15 and B15C30 achieved an increases its amount. 59.94, 42.44%, 71.64 and 43.86% less than B0C0 plants for both seasons, respectively, while the treated plants B15C15 achieved a decreases 41.24 and 47.83% than B30C30 plants for both seasons, respectively. Regarding the interaction effect between the study factors, the results of the same Table show that the number of seeds in the main inflorescence increased significantly with the increases in the levels of spraying factors according to different bio-fertilizers, especially plants contaminated with A3 seeds, as the sprayed plants B30C30 in the presence of A3 achieved an increases 359.63 and 326.84% over the plants A0B0C0 for both seasons sequentially. While the sprayed plants B30C30 in the presence of each of A2 and A1 achieved an increases 35.16, 28.88%, 16.76 and 20.86% than the plants contaminated with each of them and not sprayed for both seasons respectively. Shows The same table shows that there are significant differences in the number of seeds in the main inflorescence between the sprayed plants B15C15, B15C30 and B30C15 with the difference in bio-fertilizers compared to the plants A0B0C0 for both seasons in sequence**.**

Weight of 1000 seeds (g)

The results in Table 5 show, that plants contaminated with seeds A3 achieved an increases in the weight of thousand seeds 89.27 and 93.30% than A0 (without adding vaccine) for both seasons sequentially. whereas, plants contaminated with seeds of both A2 and A1 achieved an increases 68.29, 67.46%, 27.95 and 32.06% over A0 plants for both seasons, respectively. The results of the statistical analysis in the same Table indicate that the weight of the thousand seeds increased with the increase in the levels of the spraying combination, as the treated plants B30C30 achieved an increases 23.27 and 26.79% compared to the B0C0 plants (spraying with distilled water only) for both seasons and sequentially. While the treated plants B30C15 and B15C30 achieved an increases 19.51, 13.51%, 22.01 and 18.66 % than the B0C0 plants for both seasons, respectively, while the B15C15 treated plants achieved a decrease of 15.02 and 11.32% than the B30C30 treated plants for both seasons, respectively. Regarding the interaction effect between the study factors, it was show from the results of the same Table, that there were significant differences in the weight of thousand seeds according to the different spraying factors in the presence of bio-fertilizers, as the sprayed plants B30C30 in the presence of A3 achieved an increases 111.70 and 116.75 than the plants A0B0C0 for both seasons sequentially. While the sprayed plants B30C30 in the presences of each of A1 and A2 achieved an increases 23.66, 11.01%, 23.91 and 14.00% over the plants contaminated with each of them and not sprayed for both seasons respectively. And we note from the same table that there are significant differences in this trait between the sprayed plants B15C15, B15C30 and B30C15 by the difference of bio-fertilizers compared to the A0B0C0 plants for both seasons, respectively.

Seeds yield (kg ha^{-1})

The data in Table 5 indicates that there was a significant effect between bio-fertilizers in the trait of seeds yield of cumin, especially the plants contaminated with seeds A3 that achieved an increases 76.05 and 68.88% compared to A0 (without adding vaccine) for both seasons sequentially. It was followed by plants contaminated with seeds of both A2 and A1, which achieved an increases 55.08, 31.30%, 50.58 and 30.02% over A0 plants for both seasons, respectively. The results indicate in the same Table that the seeds yield of cumin increased with the increase in the levels of the combination of spraying with coconut endosperm fluid and tryptophan, especially the B30C30 treated plants, which achieved an increases 29.61 and 27.61% compared to B0C0 plants (spraying with distilled water only) for both seasons sequentially. It was followed by the plants treated B30C15 and B15C30, which achieved an increases 25.44, 20.52%, 23.87 and 21.34% compared to the plants B0C0 for both seasons in sequence, while the plants treated with B15C15 recorded a decreases 13.66 and 12.76% for the plants treated B30C30 for both

Table 5. Combined effect of Bio-Stimulants on the weight of 1000 seeds (g) and Seeds yield (kg h^{-1}) of cumin for both seasons

Biofertilizer (A)	Season 2019-2020 Spraying treatment B.C. (ml L^{-1})					Means (A)	Season 2020-2021 Spraying treatment B.C. (ml L^{-1})					Means (A)
	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$		B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	
A0	2.05	2.15	2.33	2.45	2.53	2.30	2.09	2.35	2.48	2.55	2.65	2.42
A1	2.62	2.73	2.87	3.08	3.24	2.91	2.43	2.89	2.96	3.54	3.42	3.05
A2	3.45	3.52	3.62	3.79	3.83	3.64	3.50	3.61	3.75	3.85	3.93	3.73
A3	3.88	3.93	4.00	4.31	4.34	4.09	4.01	4.14	4.25	4.39	4.53	4.26
$LSD_{A*B.C}$			0.0189			0.0277			0.117			0.039
Mean	3.00	3.08	3.20	3.41	3.49		3.01	3.25	3.36	3.58	3.63	
$LSD_{B.C}$			0.0409						0.063			

Seeds yield (kg h^{-1}) of cumin for both seasons

Biofertilizer (A)	Season 2019-2020 Spraying treatment B.C. (ml L^{-1})					Means (A)	Season 2020-2021 Spraying treatment B.C. (ml L^{-1})					Means (A)
	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$		B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	
A0	733.60	820.90	884.10	920.20	950.83	861.93	767.30	854.22	931.05	950.46	979.17	896.44
A1	963.20	989.20	1023.87	1064.33	1110.67	1030.25	997.67	1023.92	1044.50	1084.68	1126.46	1055.45
A2	1137.70	1188.13	1207.77	1237.17	1260.53	1206.26	1155.38	1194.25	1219.89	1244.75	1273.21	1217.50
A3	1291.47	1322.30	1361.87	1392.20	1430.53	1359.67	1295.79	1330.33	1369.62	1402.29	1437.75	1367.16
$LSD_{A*B.C}$			24.556			19.819			8.634			4.266
Mean	1031.49	1080.13	1188.14	1153.48	1119.40		1054.04	1100.68	1141.27	1170.55	1204.15	
$LSD_{B.C}$			9.837						4.432			

seasons, respectively. Regarding the interaction effect between the study factors, it was noticed that there were significant differences in seeds yield with different levels of spraying agents in the presence of bio-fertilizers, especially plants contaminated with A3 seeds, as the sprayed plants B30C30 in the presence of A3 achieved an increases 95.00 and 87.38% over the plants A0B0C0 for both the two seasons sequentially. While the sprayed plants B30C30 in the presence of each of A1 and A2 achieved an increases 15.30, 10.80%, 12.91 and 10.20% than the plants polluted with each of them and not sprayed for both seasons sequentially. From the same results revealed that there were significant differences in seeds yield between the sprayed plants B15C15, B15C30 and B30C15 by different bio-fertilizers compared to A0B0C0 plants for both seasons respectively.

Essential oil percentage (%)

The results in Table 6 show, that the percentage of essential oil increased linear significant increases with the differences in bio-fertilizers, as plants contaminated with seeds A3 recorded the highest percentage of volatile oil of 3.25 and 3.31% compared to A0 (without adding vaccine) for both seasons sequentially. Followed by plants contaminated with seeds of both A2 and A1, which scored 2.40, 1.78%, 2.72 and 2.03% for plants A0 for both seasons, respectively. The results of the same Table indicate that spraying with coconut endosperm fluid and tryptophan had a significant effect on the percentage of volatile oil for cumin seeds. Treated plants with B30C30 recorded the highest percentage of volatile oil amounting to 1.68 and 1.87% over B0C0 plants (spraying with distilled water only) for both seasons sequentially, followed by plants treated with B30C15 and B15C30 recorded 1.47, 1.35%, 1.64 and 1.42% for the B0C0 plants for both seasons, respectively, while the B15C15-treated plants compared with the B30C30-treated plants recorded the lowest percentage of oil, which was 1.04 and 1.20% for both seasons, respectively. Interaction effect between the study factors, it was found that the percentage of volatile oil in the seeds increased with the increasing in the levels of spraying agents in the presence of bio-fertilizers, especially plants whose seeds were contaminated with A3. The plants sprayed with the combination B30C30 in the presence of A3 recorded the highest percentage of oil, which was 3.64 and 3.70% compared to A0B0C0 plants for both seasons sequentially. It was followed by the sprayed plants B30C30 in the presence of both A2 and A1 for both polluted and non-sprayed plants, which scored 3.21, 2.19%, 2.93 and 2.67% for both seasons, respectively. It is also noted from the same table the significant effect of the sprayed plants B15C15, B15C30 and B30C15 by different bio-fertilizers compared to the plants A0B0C0 for both seasons sequentially.

Essential oil yield (L ha^{-1})

Table 6. Combined effect of Bio-Stimulants on the essential oil percentage (%) and Essential oil yield (L ha^{-1}) for both seasons

	Season 2019-2020						Season 2020-2021					
Biofertilizer	Spraying treatment B.C. (ml L^{-1})						Spraying treatment B.C. (ml L^{-1})					
(A)	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	Means	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	Means
A0	0.85	1.04	1.35	1.47	1.68	1.28	0.97	1.20	1.42	1.64	1.87	1.42
A1	1.78	1.84	1.90	1.92	2.19	1.93	2.03	2.25	2.53	2.60	2.67	2.42
A2	2.40	2.58	2.74	3.10	3.21	2.81	2.72	2.77	2.82	2.86	2.93	2.82
A3	3.25	3.34	3.46	3.58	3.64	3.45	3.31	3.49	3.63	3.67	3.70	3.56
$LSD_{A*B.C}$			0.079						0.107			
Means B.C.	2.07	2.20	2.36	2.52	2.68	0.062	2.26	2.43	2.60	2.69	2.79	0.069
$LSD_{B.C}$			0.033						0.050			
						Essential oil yield (L ha^{-1})						
	Season 2019-2020						Season 2020-2021					
Biofertilizer	Spraying treatment B.C. (ml L^{-1})						Spraying treatment B.C. (ml L^{-1})					
(A)	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	Means	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	Means
A0	6.23	8.55	11.97	13.54	16.00	11.26	7.46	10.25	13.22	15.59	18.28	12.96
A1	17.14	18.18	19.42	20.43	24.36	19.91	20.29	23.00	26.46	28.24	30.11	25.62
A2	27.32	30.59	33.09	38.36	40.41	33.95	31.42	33.04	34.44	35.61	37.35	34.37
A3	42.02	44.15	47.14	49.82	52.12	47.05	42.85	46.38	49.77	51.46	53.25	48.74
$LSD_{A*B.C}$			1.097						1.306			
Means B.C.	23.18	25.37	27.91	30.54	33.22		25.51	28.17	30.97	32.73	34.75	0.921
$LSD_{B.C}$			0.384						0.589			

The results in Table 6 show, the significant differences between the bio-fertilizers in the volatile oil yield of cumin seeds, especially the plants contaminated with A3 seeds, which achieved an increases 574.48 and 474.40% compared to A0 (without adding vaccine) for both seasons sequentially. It was followed by plants contaminated with seeds of both A2 and A1, which achieved an increases 338.52 and 175.12% and 318.77 and 171.98% over A0 plants for both seasons and sequentially. The results in the same Table indicate, that the yield of the volatile oil of cumin seeds increased by increasing the levels of the combination of spraying with coconut endosperm fluid and tryptophan, especially the treated plants B30C30, which achieved an increases 156.82 and 145.04% compared to plants B0C0 (spraying with distilled water only) for both seasons respectively. It was followed by plants treated B30C15 and B15C30, which achieved an increases 117.34, 92.13%, 108.98 and 77.21% compared to plants B0C0 for both seasons respectively, while plants treated B15C15 recorded a decreases of plants treated B30C30 amounting to 46.56 and 43.93% for both seasons respectively. The interaction effect between the study factors, significant differences were observed in the yield of the volatile oil of cumin seeds with different levels of spraying factors in the presence of bio-fertilizers, especially plants contaminated with A3 seeds, as the sprayed plants B30C30 in the presence of A3 achieved an increases 784.75 and 613.81% over the plants A0B0C0 for both seasons sequentially. While the sprayed plants B30C30 in the presence of each of A2 and A1 achieved an increases 47.91, 42.12%, 18.87 and 48.40% over the plants contaminated with each of them and not sprayed for both seasons respectively. It was found same results that there were significant differences in the yield of the volatile oil between the sprayed plants B15C15, B15C30 and B30C15 by different bio-fertilizers compared to A0B0C0 plants for both seasons respectively.

Percentage Cuminaldehyde in the essential oil of cumin (%): The results in Table 7 show, that there were significant effects with plants contaminated with seeds A3, which is recorded with the highest percentage of the active compound Cuminaldehyde, which was 8.32 % than A0 (without adding vaccine) for average both seasons sequentially. The results in the Table indicate, that spraying with coconut endosperm fluid and tryptophan had an significant effect on the proportion of the compound Cuminaldehyde, as the plants treated with the spray combination B30C30 recorded the highest percentage of the above active compound, which was 11.85% than the B0C0 plants (spraying with distilled water only) for average both seasons sequentially, followed by Treated plants B30C15 and B15C30 recorded 11.43 and 9.94% for both seasons, respectively. While B15C15-treated plants compared to B30C30 treated plants scored 8.80% for average both seasons, respectively. Regarding the combined significant effects between the study factors, it was noted that the proportion of the compound Cuminaldehyde in the essential oil of cumin was affected by the increase in the levels of spraying agents in the presence of bio-fertilizers, especially plants whose seeds were contaminated with A3 achieved an increases 34.71% over the plants A0B0C0 for average both seasons, sequentially. While the sprayed plants B30C30 recorded in the presence of both A2 and A1 they were 22.23 and 16.41% for both seasons respectively. It can also be noted from the same Table that the effect of sprayed plants B15C15, B15C30 and B30C15 was significant with different bio-fertilizers compared to A0B0C0 plants for both seasons, respectively.====From this study the results showed, that the factors had contributed significantly through their mechanism of action to a linear increases in most traits, flowering growth, yield and active substance of cumin plant, especially trait number of days from planting to 75% flowering of the plants (Table 1), it could be attributed the reason why plants polluted with their seeds take less days from planting to 75% flowering of plants for each treatment and more days when compared to uninoculated plants (without adding vaccine), to the superiority of these plants in most of the characteristics of vegetative growth, especially the content of leaves from total chlorophyll and macronutrients, which was positively reflected in a better balance of metabolic processes within plant tissues, or perhaps the reason for this is due to the effect of some growth-stimulating hormones secreted by the study factors, especially the spray factors represented by the endospermic fluid of coconut and the amino acid tryptophan directly on the genes responsible for revealing flower buds and early flowering by secreting the flowering hormone (Florigen), which gives a signal to the plant that the vegetative growth stage is sufficient and the transition to the flowering stage (15, 28, 35). The number of flowering inflorescences in the plant (Table 1), it was revealed that the plants whose seeds were contaminated with the mixture between vaccination were superior in this trait than other treatments. By the increase in the number of flowering inflorescences in the plant (17). It is also revealed from the same Table that the number of flowering inflorescences differed significantly with the combination of the two spraying factors, and it increased directly with the increase in their levels, as well as the interaction effect of the study factors was significant, especially the plants sprayed with a combination (30 ml L^{-1} each) in the presences mixture between vaccination that participated together in giving the largest possible number of flowering inflorescences in the plant, and this synergistic effect could be due to the containment of some growth regulators, including zeatin, which is responsible for cell division, as well as the presence of some growth-stimulating compounds. Such as auxins, which active on cell elongation and division, reduce apical dominance and release lateral bud growth, and as a result, an increase in the number of flowering inflorescences of the plant (21).

Table 7. Combined effect of Bio-Stimulants on the percentage Cuminaldehyde in the essential oil of cumin (%) for average both seasons

Biofertilizer (A)	Spraying treatment B.C. (ml L^{-1})					Means
	B_0C_0	$B_{15}C_{15}$	$B_{15}C_{30}$	$B_{30}C_{15}$	$B_{30}C_{30}$	
A0	5.06	8.80	9.94	11.43	11.85	9.42
A1	5.61	12.96	14.72	15.74	16.41	13.09
A2	6.59	16.63	17.11	20.81	22.23	16.67
A3	8.32	23.09	23.85	30.15	34.71	24.02
$LSD_{A*B.C}$			2.156			1.43
Means B.C.	6.39	15.37	16.40	19.53	21.30	
$LSD_{B.C}$			1.098			

The number of flowers per main inflorescence (flower $inflorescence^{-1}$), increases with the increasing in the study factors. Then it developed by activating the effectiveness of metabolic processes, including carbon building, which was positively reflected on the increases in the number of flowers in the main inflorescence (23), as well as the growth-encouraging substances produced by *Pseudomonas fluorescens* bacteria, such as auxins and cytokines, which cooperated with the biological compounds and hormones secreted by the spray agents. Plant that is linked to the active growth centers in the plant, which leads to encouraging the growth of plant cells and tissues, and thus increases the efficiency of the transfer of metabolic products to a large extent to meet the requirements of plant growth and energy, and this is reflected positively on an increase in the number of flowers in the main inflorescence. As for the interaction effect of the study factors, it was noted that the plants treated with (30 ml L^{-1} each) in the presence of the mixture between vaccination were significant in affecting this trait. Carbon and then the increases in the number of flowering inflorescences in the plant and thus reflected in the increases in the seeds yield. As for the percentage of knots (%), it was found that the percentage of knots of the traits were significantly affected by the difference of bio-fertilizers and spray agents, as plants polluted with the mixture between vaccination gave the highest proportion of knots for both seasons, superior to the other of the treatments from other fertilizers, and this could be attributed the ability of these fertilizers, especially the bacterial isolate *Pseudomonas fluorescens,* which is one of the growth-promoting bacteria PGPR. Activating the growth of lateral buds, which is the main source for increasing the number of flowers and its development, in addition to their vital role in preventing the fall of the flower organs through the processes of pollination and fertilization, which contributes to the success of fruit set (2). The interaction effect of the study factors contributed to achieving the best results, especially the plants treated with the combination of spraying (30 ml L^{-1} for each) in the presence of the mixture between vaccination due to their participation in the production of many organic and biological substances stimulating growth by increasing the metabolic products of the plant by increasing the total chlorophyll pigment. Which is the main and influencing factor in the plant's response to adequate photoperiods, and this is positively reflected in the increases in the products of carbon metabolism, including carbohydrates, and increases in the number of flowering inflorescences per plant (Table 1) and the improvement of the rate of knots (21). The number of days from planting to full maturity (Table 4) a variation in the number of days. Also, the treatment of the spraying mixture (30 ml L^{-1} each) was superior to the other levels of the spraying mixtures compared to the non-polluted and non-sprayed (comparative) plants, which took more days to reach this stage, and a difference of 20 and 22 days between them for both seasons. The effect of this study factors to this trait had accelerated the filling of the bean by taking the plant enough light and the necessary nutrients, in addition to their participation together in the production of many plant hormones that stimulate growth, including cytokinin's, which contribute to stimulating vital processes through the production of larger quantities of chloroplasts and chlorophyll, thus delays the process of yellow leaves and delays aging (16). Also, these plants were early in the flowering stage (Table 1) and responded to the study factors significantly in the characteristics of flowering growth, especially the number of flowering inflorescences in the plant and the percentage of knots (Tables 1 and 3). As for the interaction effect of this study factors, it was revealed from the results of the same Table that there was no significant effect for them in this characteristic for both seasons. The vital activities and mechanisms of the aforementioned study factors were positively reflected in the superiority of the indicators of the seeds yield and its effective components, as evidenced by the increases in the number of seeds in the main inflorescence (Table 4), which is one of the important indicators in determining the seeds yield and its components in quantity and quality. The main objective in the production of most field crops. It was noted that this characteristic increased in the presence of bio-fertilizers for both seasons, especially plants whose seeds were contaminated with the mixture between vaccination that were treated with a combination of spraying (30 ml L^{-1} each). This leads to an increase in most characteristics of vegetative growth, including total chlorophyll and macronutrients, which was reflected in the increases in the products of carbon metabolism to meet the flower's need for nutrients necessary to ensure the formation and knotting of seeds, and nitrogen has an effective role contributing to the increases in the number of inflorescences, the number of flowers in the main inflorescence, and the percentage of knots (Tables 1, 2 and 3). This is significantly reflected by the increases in the number of seeds in the main inflorescence, in addition to the role of the zeatin compound secreted by spray agents, especially the coconut endosperm fluid, which is known to represent a form of natural cytokinin that prevents or reduces apical dominance in plants, which triggers the growth of lateral buds followed by an increase in the number of main branches of the plant, the total chlorophyll content of the leaves, the number of inflorescences and the number of flowers in the main inflorescence, as a result, was positively reflected on this trait, and about the weight of the thousand seeds (Table 5) (10). This trait is one of the main components of the yield as it expresses the degree of filling the seeds with dry's matter and depends on the power of the estuary as a recipient of the products of photosynthesis. The other reason and a direct increases with the increase in the levels of the two factors spraying with the endosperm liquid of coconut and the amino acid tryptophan, and the reason could be attributed to the fact that the same plants achieved superiority in the number of flowering inflorescences in the plant, the number of flowers in the main inflorescence, the percentage of knots (Table 1, 2 and 3) and seeds number per the main inflorescence

(Table 4), which indicates that the plants treated with biofertilizer invested their ability to support the plant and supply it with nutrients necessary to activate metabolic processes, especially the photosynthesis process, which led to the formation of a good vegetative group and thus increased the accumulation of nutrients such as carbohydrates and proteins in the seeds, which led to an increase in The weight of the thousand seeds (7), as well as the cooperative and joint effect among the factors of the study in showing this trait, especially the plants Sprayed (30 ml L^{-1} each) in the presence of the mixture between vaccination , improved the vegetative growth characteristics such as the height of the main stem, the dry weight of the shoot and the content of the fresh leaves of chlorophyll, which led to an increase in the products of photosynthesis due to an increase in its resistance to light and its ability to secrete many biological compounds that stimulate growth, since the seeds are among the estuaries in which the products of photosynthesis are concentrated in a concentrated manner, thus it was positively reflected in the increases this trait compared to the non-polluted and non-sprayed plants (the comparison). The seeds yield (Table 5), seed yield is one of the basic components of seeds production that depends on the physiological and morphological characteristics that affect the different stages of growth. As we note from the same results, that plants whose seeds were contaminated with the mixture between vaccination effectively contributed to an increases in the total chlorophyll content of the leaves, which means an increases in the efficiency of the photosynthesis process and a positive reflection on the abundance of vegetative and floral growth, and as mentioned previously, and this in total led to an increases in seeds yield. In addition to the role of the study factors, especially that the plants sprayed (30 ml L^{-1} each) with the mixture between vaccination were more responsive in expressing their efficiency in most of the studied traits, which in turn was positively reflected in the increase in the final yield of seeds. The percentage of Essential oil (Table 6), as this trait in seeds is one of the important indicators in determining the yield of the resulting oil in quantity and quality, so this trait is quickly affected by internal factors such as plant hormones and by external factors such as environment and plant type (8). It is noted from the results in (Table 6) that the percentage of volatile oil increased in plants whose seeds were contaminated with the mixture between vaccination , and the reason could be due to the vital role of these bacterial vaccines in fixing atmospheric nitrogen, which helped the plant to increases the efficiency of metabolic activities in the plant, especially photosynthesis, which in turn It led to an increases in the production of compounds and active substances, including essential oils, which are byproducts of photosynthesis (19), in addition to what is produced by the two spray agents represented by the coconut endosperm fluid and tryptophan, which represent one of the forms of natural growth stimulants such as cytokinin and auxin, which are naturally created inside plant cells as they stimulate growth and cell division, which has been positively reflected in increasing plant growth and development in quantity and quality (25, 35). The interaction effect of this study factors, especially the sprayed plants (30 ml L^{-1} each) in the presence of the mixture between vaccination, which were not isolated from each other, as their use together had a significant effect on the vegetative and flowering growth, especially in the number of flowering inflorescences in the plant and the seeds number per the main inflorescence, and seeds yield (Tables 1, 4 and 5). The essential oil yield is also one of the important vital traits, and it is affected by two main characteristics, namely, the seeds yield and the proportion of volatile oil, which participate in the outcome in determining the total yield of volatile oil. It was noticed from (Table 6) that plants whose seeds were contaminated with the mixture between vaccination achieved a significant superiority over the rest of the fertilizers compared to the uninoculated plants (without adding vaccine) by giving them the highest oil yield for both seasons, as the study factors had previously had a significant effect in increasing the percentage of essential oil as well as in the seeds yield (Tables 5 and 6) as a result of the efficiency of metabolic processes, especially photosynthesis and respiration, which led to an increases in the accumulation of dry matter at the source and its transfer to the downstream (seeds), which reflected positively on an increases in the yield of volatile oil (26). The reason could be attributed to the interaction effect of the study factors, especially when treating plants with a combination spray (30 ml L^{-1} for each) in the presence of the mixture between vaccination as a results of their containing many vital compounds and natural plant hormones such as Auxin, Gibberellin, cytokinin and Zeatin because of their effect The biological active in cell division, raising the efficiency of vital processes and increasing their metabolic products, as well as providing the nutrients necessary for plant growth and development, as the amount of oil depends on the manufacture and accumulation of primary nutrients such as carbohydrates in the seeds, and thus this is reflected positively on the increases in the yield of volatile oil (8). The effect of biological fertilizers in stimulating the production of active compounds in the essential oil of cumin seeds, especially the main compound Cuminaldehyde, we note from the results in Table 7 show that plants sprayed with (30 ml L^{-1} each) in the presence of the mixture between vaccination gave the highest increases in the area ratio of the compound compared to the reason could be attributed to the increases this treatment in the indicators of floral growth characteristics (Table 1-4) and yield (Table 4,5), as well as the increases in the percentage of essential oil and its yield (Table 6), which led to a higher amount of this compound inside the Essential oil, which is an indicator of the accumulation of carbon-building products that constitute the biosynthesis of oxygen compounds, thus reflected positively in the manifestation of this characteristic, in addition to the vital role of the agents of spraying with the endosperm liquid of coconut and the amino acid tryptophan, which participated in the secretion of vital compounds such as cytokinin's, auxins and acids the amino, organic and enzymes necessary in the production of active compounds and the increases solid oxygen compounds and their accumulation in the essential oil of the cumin plant (1). The increases in the area ratio of the aforementioned effective compound when treating plants with the interaction effect of the study factors, especially plants treated with a combination spray (30 ml L^{-1} each) in the presence of the mixture between vaccination , and the reason could be attributed to the synergistic effect among them in improving the efficiency of metabolic processes, especially The process of photosynthesis and the increases its products, and their accumulation in the plant parts, which leads to an increases in the production of secondary metabolic compounds, including volatile oils, an increases in the number and size of oil glands, the accumulation of oils in them and an increases in the oxygen compounds in the volatile oil (2, 20).

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