Effect of sprays of licorice and seaweed extracts on yield and Quality of corn (Zea mays L.)

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Abstract

A field experiment was conducted in autumn season (2022) on one of the farms in Al-Madhatiya district, south of Babylon province (randomized complete block design (RCBD) as a factorial experiment). The experiment included three factors, namely licorice extract and three concentrations (0, 5, 10) mg.L^{-1} and are coded (L0, L1, L2). The second factor is adding seaweed extract sprayed on the leaves at three concentrations (0, 4, 8 mg L^{-1}) and are coded (A0, A1, A2). The third factor is the number of sprays and Three sprays (once, twice, and three times) were coded (N1, N2, N3). Thus, the experiment included 27 treatments for each replicate, and the total number of experimental units reached 81 experimental units. The results showed the following:

1-The licorice extract at a concentration of 10 mg.L^{-1} (L2) excelled in all the characteristics studied, including (number of cob, total yield kg ha^{-1}, protein percentage, oil percentage%) by giving it the highest means of (32.03) grain.cob $^{-1}$.53.34 g - 1.9.82% 4.82%.)

2 -The seaweed extract at a concentration of 8 mg L^{-1} (A2) excelled in all the studied characteristics, including (number of grains, oil percentage, protein percentage), by giving it the highest means of (34.66 grains.cob^{-1}, 5.10%). , 10.20%)

3-As for the spraying periods, the spraying treatment was three times higher in the studied characteristics, including (weight of 300 grains g^{-1}, oil percentage, protein percentage%) by giving it the highest means of (53.86 g^{-1}, 5.37%, 10.53%.)As for the binary interactions between licorice and seaweed , licorice and the number of sprays, and algae and the number of sprays, the treatments (L2, A2, N3) and the concentration (10 mg L^{-1} licorice, 8 mg L^{-1} seaweed , for three sprayings) were superior in some of the studied traits. Including (the number of grains in a row, and the percentage of oil), by giving them the highest means, which amounted to (36.60 grains, row^{-1}, 35.96 grains, row^{-1}, 38.94 grains, row^{-1}), (5.32, 5.47, 5.57%), while it was insignificant for the season in the percentage Protein.As for the triple interactions of the three elements of licorice and seaweed and the number of sprays, the combination (L2A2N3) (at a concentration of 10 mg L^{-1} licorice, 8 mg L^{-1} seaweed and the number of sprays) gave the combination, and for three sprays the highest means in some of the studied characteristics, including (number of grains row^{-1}, oil percentage %, amounted to (41.05 grains cob^{-1}), (6.09%).

introduction

corn (Zea mays L.) is one of the important economic crops in Iraq, the Arab world and the world. It is the third most important crop in terms of production and area after wheat and rice. It has multiple uses as food for humans and feed for animals and is used in the paper industry and oil and dyes, as well as its high production capacity and its adaptation to climatic conditions[1] The economic value of yellow corn lies in the yellow corn grain containing a high percentage of protein 11.3%, oil 5.4% and carbohydrates 82%, in addition to the grains containing vitamins B1, B2 ,E. The mean global production per hectare was 12,524 tons -1 , while in Iraq the mean production was 4,315 tons.ha^{-1} [2]. This is

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evidence of the low level of productivity in the country compared to global production. Therefore, it is necessary to raise the level of productivity by using various methods, including the cultivation of high-productivity varieties and the use of modern agricultural machinery and methods that lead to increased production, including the use of foliar nutrition such as licorice extract and seaweed extract instead of chemical fertilizers. [3] .The plant extract is useful in increasing the efficiency of the photosynthesis process and then increasing production, and this is reflected positively on vegetative growth in general, then the fruitful growth of maize and the total yield[4] .Foliar nutrition is one of the most important methods of supplying the plant with its nutritional needs. Foliar nutrition is done by spraying the vegetative parts of plants in dilute solutions of these nutrients for several times. Plant extracts are available, cheap and easy to use and therefore do not lead to environmental pollution and can be used to replace many nutrients important and some acids[5] The study aims to know effect of sprays of licorice and seaweed extracts on yield and Quality of corn (Zea mays L)

Materials and methods

Experiment location

A field experiment was conducted during the spring season of 2022, on 3/15/2022, respectively, in Babylon province / Al-Medhatiyah District, for the purpose of studying the effect of the number of sprays of licorice extracts and seaweed on the growth and yield of yellow corn (Zea mays L.). Seeds of the cultivar Rafidain were obtained from Abu Ghraib Research Station.

Experiment design

The experiment was designed according to the randomized complete block design (RCBD) as a factorial experiment with three factors.The first factor, three concentrations of licorice extract (0, 5, 10) gm L^{-1} were given the following symbols: (L0,L1,L2).The second factor, three concentrations of seaweed (0, 4, 8) mg L^{-1} were given the following codes (A0, A1, A2).The third factor, three sprays for once, twice, and three times (4-6 leaf, 8-10 leaf, 12-14 leaf) in addition to control treatment, and the following symbols were given (N1, N2, N3) and with three replications, as the number of experimental units reached (81) experimental unit.The soil of the field was analyzed before planting for Spring season to study some of its chemical and physical traits in the laboratories of Al-Musayyib Technical Institute, by taking samples at a depth of 30 cm, table number (3). Lines The distance between one line and another is 75 cm, and between one jar and another is 25 cm.

Table 3. Some chemical and physical properties of the soil sample used before planting for Spring season

Autumn season	Spring season	units	traits
7.1	7.3	-	Ph
3.6	2.8	$DS.m^{-2}$	Ec
30.6	35	$mg.kg^{-1}$	N
17.6	18.7	$mg.kg^{-1}$	P
128	121	$mg.kg^{-1}$	K
			Soil separates
138	431	$g.kg^{-1}$	sand
444	406	$g.kg^{-1}$	silt
418	163	$g.kg^{-1}$	clay
Silty loam clay	Silty loam sandy	-	texture

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Phosphate fertilizer, triple calcium superphosphate, was added before planting, 20% P at a rate of 200 kg ha, and urea fertilizer 46% N was added at a rate of 320 kg ha^{-1}, in two batches at planting and a month after planting[6] by spreading the fertilizer on a line 5 cm away from Planting line: On one side only the seeds were sown by placing 2 seeds in pit, then thinned to one plant when the plants reached a height of (15-20) cm.Spraying the field with atrazine 80% effective substance (4 kg ha^{-1}) after planting and before the emergence of seedlings, in order to control the annual weeds while continuing to remove the weeds whenever the need arises. Granular diazinon 10% active substance, at the amount of 6 kg ha, in two batches, the first after 20 days of germination, and the other after 15 days of the first batch [7] . The crop was harvested after the plants reached the stage of physiological maturity.

Studied traits:

First: traits of the product and its components

Upon completion of physiological maturity, five stalks were taken from the two middle lines randomly for each experimental unit and the following traits were studied [8]

1- The number of grains per cob $^{-1}$). Five ears were taken from each experimental unit, then they were separated and calculated by dividing the total number of ears by the total number of ears to obtain the number of grains per ear.

2-Total yield (kg ha^{-1}). The yield of each plant was calculated in grams with a sensitive balance, then the total grain yield in tons was calculated at a standard humidity of 15.5% according to the following equation (total grain yield in tons ha^{-1} = mean yield of one plant x plant density) [9]

Second / qualitative traits

-1The percentage of protein in the grains. The percentage of protein in the seeds was calculated using the Micro Kjeldahl method according to [10] The dry seeds were ground and 0.4 grams were taken from each experimental unit in all varieties. After that, the samples were wet digested using concentrated sulfuric acid and perchloric acid in 50 mm glass flasks. When digestion was complete, total nitrogen was calculated from the following equation:

Protein percentage (%) = total nitrogen percentage x 6.25.

2- The percentage of oil in the seeds. It was measured according to the official method of the American Oil Association A.O.A.C 1976. Using a soxhlet device, where 10 grams of the ground dry sample of the seeds were taken for each treatment and placed in the extraction device. The oil was extracted using hexane, and after the solvent evaporated, the oil samples were weighed and the percentage of oil was calculated. According to the following equation:

Percentage of oil (%) = Weight of oil / Weight of dry sample x 100 as per A.O.A.C. 1976.

statistical analysis

A factorial experiment was applied according to a randomized complete block design (R.C.B.D.), and the data were analyzed for the studied traits and the arithmetic means were compared according to the least significant difference test (L.S.D.) under a 5% probability level [11] The Genestat statistical analysis program was used to distinguish differences between treatments.

Results and discussion

Mean number of grains.cob $^{-1}$

Table (2) shows that the L2 licorice spray treatment was excelled on the rest of the levels for the number of grains.cob $^{-1}$, giving it the highest mean of 411.62 grains.cob $^{-1}$. While level L0 gave the lowest mean for the trait, amounting to 359.80 grains.cob $^{-1}$. The reason for the increase in the number of panicle seeds in plants sprayed with licorice root extract is due to the increased presence of mineral elements that work to accelerate the growth of the pollen tube, which encouraged the process

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of fertilization, grain formation, and increased number [12] As for the seaweed spraying treatment, treatment A2 was distinguished by giving the highest mean for the trait, amounting to 406.80 grains.cob $^{-1}$. While treatment A0 was distinguished by giving it the lowest mean of 365.73 grains.cob $^{-1}$. The reason for the excelled may be due to the nutritional elements and growth-stimulating compounds the extract contains and its effect in increasing the leaf area, as the leaf area plays great importance as it is the part that intercepts the sunlight necessary for carbon assimilation. It contributes the largest portion of manufactured materials and is an important storehouse for these materials, which are considered a source and then transported to the downstream sink, thus increasing the number of grains per cob. [13]As for the effect of the number of sprays on the character of the number of grains.cob $^{-1}$, treatment N3 was distinguished by giving it the highest mean of 433.92 grains.cob $^{-1}$ As for treatment N1, it gave the lowest mean, amounting to 332.34 grains.cob $^{-1}$. As for the interaction between licorice and seaweed, the combination L2 A2 was distinguished by giving the highest means for the trait, amounting to 438.96 grains.cob $^{-1}$, while the combination L0 A0 gave the lowest values for the means of the studied trait, amounting to 345.92. As for the interaction between licorice and the number of sprays, the combination L3 N3 was distinguished by giving the highest mean for the trait, amounting to 473.35 grains.cob $^{-1}$, while the combination L0N1 gave the lowest values for the means of the studied trait, amounting to 320.58 grains.cob $^{-1}$ .As for the interaction between seaweed and the number of sprays, the combination A2 N3 was distinguished by giving the highest mean for the trait, amounting to 464.42 grains.cob $^{-1}$. As for the combination A0 N1, it gave the lowest mean for the characteristic, which amounted to 327.16 grains.cob $^{-1}$. As for the triple interaction, the combination L2A2N3 excelled by giving it the highest mean for the trait, amounting to 502.82 grains.cob $^{-1}$ .As for the combination L0 A0N1, it gave the lowest means for the trait, amounting to 317.70 grains.cob $^{-1}$.

Average total yield (kg ha^{-1})

Table (2) shows L2 licorice spray treatment excelled on the rest of the levels for the total yield traits, kg ha^{-1}, by giving it the highest mean of 12259.52 kg ha^{-1}. While level L0 gave the lowest mean for the trait, amounting to 11214.78 kg ha^{-1}. The reason for the increase in the total yield of the plant sprayed with licorice root extract may be due to the extract containing nutritious and stimulating chemicals at the same time, in addition to its containment of sugars, proteins, amino acids, mineral elements and vitamins. Because the mentioned chemical compounds can be ready food to increase the total yield of the plant, in addition to the fact that the extract led to an increase in the cob length, the number of grains per cob, the weight of 300 grains, and the yield of one plant [14] since spraying the wheat plant with licorice extract has increased the yield As for the seaweed spraying treatment, treatment A2 was distinguished by giving the highest mean for the trait, amounting to 12,308.81 kg ha^{-1}. While the A0 factor was distinguished by giving the lowest mean of 11010.19 kg ha^{-1}. This may be due to the extract containing organic acids, proteins and carbohydrates that work to delay the aging of the shoot, which was reflected in the overall yield of the plant, in addition to the effect of the extract on increasing the stalk length, the number of seeds per stalk, the weight of 300 seeds, and the yield of one plant [15] from spraying the extract. On maize, it has increased the total yield.As for the effect of the number of sprays on the character of the total yield, kg ha^{-1}, treatment N3 was distinguished by giving it the highest mean of 12643.78 kg ha^{-1}.As for treatment N1, it gave the lowest mean, amounting to 10,642.59 kg ha^{-1}. As for the interaction between licorice and seaweed , the combination L2 A2 was distinguished by giving the highest means for the trait, amounting to 13,102.56 kg ha-1, while

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combination L0 A0 gave the lowest values for the means of the studied trait, amounting to 10,547 kg ha^{-1}As for the interaction between licorice and the number of sprays, the combination L3 N3 was distinguished by giving it the highest mean for the characteristic swallowing, 13152.11 kg ha^{-1}.

As for the interaction between seaweed and the number of sprays, the combination A2 N3 was distinguished by giving the highest mean for the trait, amounting to 12964.22 kg ha^{1}.

As for the triple interaction, the combination L2A2N3 excelled by giving it the highest mean of traits, amounting to 13631 kg ha^{-1}. As for the combination L0 A0N1, it gave the lowest means for the characteristic, amounting to 9325 kg ha^{-1}.

Table (2) The effect of the number of sprays of licorice and seaweed extracts on the number of grains.cob $^{-1}$, for autumn season 2022.

mean L*A	N			A	L
	N3	N2	N1		
345.92	376.30	343.77	317.70	**A0**	**L0**
364.60	400.41	373.69	319.72	**A1**	
368.87	403.89	378.40	324.31	**A2**	
370.12	407.18	377.88	325.29	**A0**	**L1**
373.29	410.88	382.20	326.78	**A1**	
412.57	486.55	423.46	327.70	**A2**	
381.14	426.77	378.16	338.50	**A0**	**L2**
414.76	490.47	407.70	346.12	**A1**	
438.96	502.82	449.09	364.96	**A2**	
8.13	14.07				**LSD 0.05**
	mean L*N				
359.80	393.53	365.28	320.58		**L0**
385.32	434.87	394.51	326.59		**L1**
411.62	473.35	411.65	349.86		**L2**
4.69	8.13				**LSD 0.05**
	A*N mean				
365.73	403.42	366.60	327.16		**A0**
384.22	433.92	387.86	330.87		**A1**
406.80	464.42	416.98	338.99		**A2**
4.69	8.13				**LSD 0.05**
	433.92	390.48	332.34		**N mean**
	4.69				**LSD 0.05**

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Table (3) The effect of the number of sprays of licorice and seaweed extracts on the total yield (kg ha^{-1}) for autumn season 2022.

mean L*A	N			A	L
	N3	N2	N1		
10547.67	11744.67	10573.33	9325.00	A0	
11456.89	12865.00	11759.00	9746.67	A1	L0
11639.78	12359.67	11623.00	10936.67	A2	
11343.56	12479.67	11989.00	9562.00	A0	
11778.44	11986.67	12835.67	10513.00	A1	L1
12184.11	12902.00	12146.33	11504.00	A2	
11139.33	12411.33	11245.67	9761.00	A0	
12536.67	13414.00	12382.00	11814.00	A1	L2
13102.56	13631.00	13055.67	12621.00	A2	
441.71	765.16				LSD 0.05
	mean L*N				
11214.78	12323.11	11318.44	10002.78		L0
11768.70	12456.11	12323.67	10526.33		L1
12259.52	13152.11	12227.78	11398.67		L2
255.02	441.71				LSD 0.05
	A*N mean				
11010.19	12211.89	11269.33	9549.33		A0
11924.00	12755.22	12325.56	10691.22		A1
12308.81	12964.22	12275.00	11687.22		A2
255.02	441.71				LSD 0.05
	12643.78	11956.63	10642.59		N mean
	255.02				LSD 0.05

Mean protein content (%)

Table (4) shows that the L2 licorice spray treatment outperformed the rest of the levels of the protein content trait, giving it the highest mean of 10.07%. While level L0 gave the lowest mean for the trait, amounting to 9.24%. The reason is that the roots of licorice contain essential elements, including Mg, which participates in the formation of the chlorophyll molecule, which is involved in the process of photosynthesis. Thus, the physiological processes inside the plant increase, resulting in an increase in organic materials inside the leaves, which are transferred from the places of production in the leaves to places. Storage in grains, which includes nitrogen, results in an increase in protein within the grains. These results are consistent with the findings of [16] by spraying licorice root extract on wheat plants.

As for the seaweed spraying treatment, treatment A2 was distinguished by having the highest mean for the trait, amounting to 10.32%. While treatment A0 was characterized by giving it the lowest mean of 9.13% respectively, the reason for the increase in the percentage of protein may be due to the increase in the concentration of the elements nitrogen and magnesium as a result of what the extract provides when spraying plants with this element, thus increasing the chlorophyll content of the leaves, which results in an increase in the process of carbon metabolism and thus Increase protein synthesis. Preparing the extract with major elements, including potassium, which is important in reducing nitrates and forming proteins, thus increasing the quality of the final yield produced by the plant. Also, preparing the algae fertilizer with potassium contributes to activating the work of enzymes for protein synthesis, especially

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synthetase enzymes. The increase in the protein content of the seeds may be due to the effect of the extract on protein synthesis by raising the dissolved nitrogen content and then representing the inorganic nitrogenous compounds in the form of amino acids necessary for protein synthesis [17]

As for the effect of the number of sprays on traits of the protein percentage, the N3 treatment was distinguished by giving it the highest mean of 10.95%.

As for the treatment N1, it gave the lowest mean, amounting to 8.16%. As for the interaction between licorice and seaweed , the combination L2 A2 was distinguished by giving the highest means for the trait, amounting to 10.66%, while the combination L0 A0 gave the lowest values for the means of the studied attribute, amounting to 8.37%. As for the interaction between licorice and no. Sprays and the interaction between seaweed and the number of sprays, there are no significant differences between trait. As for the triple interference, the combination L2A2N3 excelled by giving it the highest mean for the trait, amounting to 11.49%. The combination L0 A0N1 gave the lowest means for the trait, reaching 7.20%.

Table (4) The effect of the number of sprays of licorice and seaweed extracts on the trait of protein percentage (%) for autumn season 2022.

mean L*A	N			A	L
	N3	N2	N1		
8.37	9.50	8.41	7.20	A0	
9.59	10.34	9.62	8.80	A1	L0
9.76	11.54	10.17	7.58	A2	
9.28	10.67	9.68	7.47	A0	
9.62	11.19	10.05	7.63	A1	L1
10.53	11.23	10.49	9.87	A2	
9.74	11.18	10.64	7.39	A0	
9.82	11.43	10.20	7.81	A1	L2
10.66	11.49	10.77	9.71	A2	
0.75	Ns				LSD 0.05
	mean L*N				
9.24	10.46	9.40	7.86		L0
9.81	11.03	10.08	8.32		L1
10.07	11.37	10.54	8.30		L2
0.43	Ns				LSD 0.05
	A*N mean				
9.13	10.45	9.58	7.35		A0
9.68	10.99	9.96	8.08		A1
10.32	11.42	10.48	9.05		A2
0.43	Ns				LSD 0.05
	10.95	10.01	8.16		N mean
	0.43				LSD 0.05

Mean oil content (%)

Table (5) shows that the L2 licorice spray treatment excelled on the rest of the levels of the oil percentage giving it the highest mean of 5.02%. While level L0 gave the lowest mean for the trait, 4.78%. The reason for this may be due to the extract containing many growth-stimulating substances such as mineral elements, vitamins, sugars, sterols, amino acids, starch, and some mineral elements, and it works to increase the chlorophyll pigment in the leaves, thus increasing the process of photosynthesis, which leads to the transfer of substances manufactured in the leaves to the grains, and thus the percentage of oils in the grains increases [18]. These results are consistent with what [19] concluded that spraying licorice extract on yellow corn plants

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causes an increase in the percentage of oils in the grains.

As for the seaweed spraying treatment, treatment A2 was distinguished by giving the highest mean for the trait, amounting to 5.10%. While treatment A0 for both the spring and autumn seasons was characterized by giving it the lowest mean of 4.49%, the reason for the increase in the percentage of oil may be due to the ability of the extract to increase the efficiency of the photosynthesis process, leading to an increase in the accumulation and transfer of nutrients from the sites of formation to the sites of storage, causing an increase in oil production, which is The main product in the photosynthesis process [20]

As for the effect of the number of sprays on the character of oil percentage, treatment N3 was distinguished by giving it the highest mean of 5.65%. Treatment N1 gave the lowest mean of 4.17%. As for the interaction between licorice and seaweed , the combination L2 and A2 was distinguished by giving it the highest means of the trait of 4.17%. 5.54%, while the combination L0 A0 gave the lowest values for the means of the studied trait, amounting to 4.34%. As for the interaction between licorice and the number of sprays it was not significant.

As for the interaction between seaweed and the number of sprays, the combination A2 N3 was distinguished by giving the highest mean for traits, amounting to 6.06%, while the combination A0 N1 gave the lowest mean for trait, amounting to 3.39%. As for the triple interaction, the L2A2N3 combination excelled by giving it the highest mean for the trait, amounting to 6.35%. The combination L0 A0N1 gave the lowest means for the trait, reaching 3.28%.

Table (5) The effect of the number of sprays of licorice and seaweed extracts on oil percentage (%) for autumn season 2022.

mean L*A	N			A	L
	N3	N2	N1		
4.34	4.85	4.88	3.28	**A0**	**L0**
4.92	5.67	4.68	4.41	**A1**	
5.08	6.03	5.06	4.15	**A2**	
4.63	5.58	4.97	3.35	**A0**	**L1**
5.10	5.52	4.93	4.83	**A1**	
5.15	5.80	5.21	4.44	**A2**	
4.50	5.29	4.67	3.55	**A0**	**L2**
5.02	5.73	4.84	4.48	**A1**	
5.54	6.35	5.26	5.00	**A2**	
0.22	0.39				**LSD 0.05**
	mean L*N				
4.78	5.52	4.87	3.95		**L0**
4.96	5.63	5.04	4.21		**L1**
5.02	5.79	4.93	4.34		**L2**
0.13	NS				**LSD 0.05**
	A*N mean				
4.49	5.24	4.84	3.39		**A0**
5.01	5.64	4.82	4.58		**A1**
5.26	6.06	5.18	4.53		**A2**
0.13	0.22				**LSD 0.05**
	5.65	4.95	4.17		**N mean**
	0.13				**LSD 0.05**

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