Effect of seaweed fertilization and spraying with Tecamin Max on some qualitative traits of corn (*Zea mays* L.)

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Abstract

A field experiment was carried out during the spring season of 2024 in the experimental fields of district Al-Husseiniya, Kerbala, Iraq, with the aim of studying the effect of soil fertilization with seaweed and spraying with the nutrient solution Tecamin Max on some growth and quality indicators of corn variety of 5018. The complete randomized block design was used according to the arrangement of factorial experiments with three replicates and two factors. The first factor included four concentrations of soil fertilization with seaweed, which are 0, 4, 8, and 12 kg ha-1, while the second factor included four different concentrations of foliar spraying with Tecamin Max, which are 0, 1, 2, 3 ml L-1. The results showed that the treatment of adding seaweed 12 kg h-1 was superior in giving the highest rate of the characteristics of nitrogen percentage, phosphorus percentage, potassium percentage, protein percentage, oil percentage, which reached (1.4533%, 0.555%, 0.4250%, 9.083%, 4.212%) respectively, compared to the comparison treatment which gave the lowest values. The results of foliar spraying with Tecamin Max compound showed that the level of 3 ml L-1 was superior in giving the highest rate for the same characteristics above which reached (1.4242%, 0.512%, 4.158%, 8.901%, 3.687%) respectively. Regarding the interaction between the study factors, the results showed no significant interactions, which means that the study factors behaved separately.

Keywords: Corn, nutrient solution, seaweed, Tecamin Max.

Introduction

Given the importance of the corn crop and its low quality, it is necessary to find ways to increase its production and improve its quality, and to achieve this purpose, seaweed extracts are used as organic fertilizers. In addition to being compounds from natural sources, they contain many growth-promoting hormones such as auxin, gibberellins, cytokinins, vitamins, amino acids [1], and micronutrients, which have proven successful as supplementary fertilizers added with mineral fertilizers to increase the efficiency of the carbon metabolism process and improve plant growth and yield [2]. Nutrient solutions such as Tecamin Max have also appeared, which contains 14.4% amino acids, 8% nitrogen, and 50.0% organic matter in its composition. When sprayed

on plants, it causes increased growth and production of economic crops and plays dual roles in biomanufacturing processes[3]. found in her study that spraying three concentrations of seaweed 1, 1.5, 2 gm L-1 on corn exceeded the concentration of seaweed extract 1 g L-1 in the percentage of nitrogen, phosphorus, potassium and protein in the grains at a rate of 1.75%, 0.40%, 3.33%, 10.94% respectively. [4] showed in a study on seaweed that spraying the compound Algazone Mx30 at concentrations of 2 and 4 ml L-1 on corn exceeded the concentration of seaweed extract 4 g L-1 in the chlorophyll index in the leaves by an average of the percentage of nitrogen and phosphorus in the grains by an average of 16.66% and 5.34%, respectively, and the same concentration exceeded the percentage of protein and oil in the grains by an average of 13.35% and 3.90%, respectively. [5] concluded the importance of adding levels and dates of fertilization with liquid amino fertilizers Tecamin Max in accelerating plant growth and its mineral content of nutrients, when spraying three concentrations of 0 and 2 ml/liter and 4 ml/liter for each of the amino fertilizer (Tecamin Max) and the liquid organic fertilizer (Viveter), as the most important results showed that the concentration of 4 ml/liter for each of the two fertilizers gave the highest significant increase in the leaf content of nitrogen, phosphorus, potassium and protein. Due to the low quality of the crop in the spring season, this study was proposed with the aim of determining the best concentration of seaweed and the Tecamin Max compound and the interaction between them that could give the highest significance in some growth and quality traits of corn.

Materials and Methods

A field experiment was conducted during the spring season of 2024 using a randomized complete block design (RCBD) according to the factorial experiment arrangement with three replicates and two factors, the first includes four ground concentrations of seaweed 0, 4, 8, 12 kg h-1, symbolized by A0, A1, A2, and A3, respectively which consists of (Total nitrogen N available 0.7- 1.5%, Phosphate P2O5 Soluble 0.2 -1.1%, Potash K2O 17.0 -22.0%, Total Amino Acids 4.0), and the second factor includes four different concentrations of the Tecamin Max compound, which are 3, 2, 1, and 0 ml l-1, symbolized by N1, N0, N3, and N2, respectively which consists of) amino acids 14.4%, nitrogen 8%, organic matter 50.0%). The field soil was analyzed to determine some of its chemical and physical properties according to the method described previously [6].

Soil and crop service operations were carried out by plowing according to the recommendations of the Ministry of Agriculture. Cultivation was carried out on rows with a distance of 75 cm between rows and 25 cm between holes. The area of the experimental unit was 9 m With 48 experimental units. Corn seeds, variety 5018, were planted on 23/3/2024. Nitrogen fertilizer was added in the amount of 320 kg ha-1 in the form of urea fertilizer 46% N divided into three batches, the first at the germination stage, the second at the elongation stage, and the third at flowering [7]. DAP fertilizer P%48 was also added at planting in the amount of 200 kg ha-1 p, and seaweed was

added at the stage of six true leaves, and Tecamin Max was sprayed once at the stage of ten true leaves[8]. The samples were analyzed in the laboratories of the Directorate of Agriculture-Karbala Governorate, and the results appeared as in (Table 1).

Table (1): Some chemical and physical traits of field soi

value	Unit	Trait
E.C (1:1)	DC-Siemens M-1	2.38
pH	-	7.24
O.M	g kg-1 soil	1.43
N	mg kg-1 soil	32.11
P		11.9
K		74.27
Soil separators		
Clay	%	470
Sand		180
Silt		350
Soil texture		Mixed clay

Studied traits

Nitrogen Percentage %: The nitrogen element percentage in the grains was estimated by Kjeldahl Apparatus by taking 10 ml of the digested sample and adding 10 ml of sodium hydroxide NaOH concentration 40%, then distillation was carried out and then the released ammonia was collected in a glass flask containing 20 ml of boric acid concentration 2% and a mixture of Methyl Red Bromocresol Green, then the collected ammonia was filtered with hydrochloric acid (HCl) and by knowing the amount of the filtered acid, the total nitrogen was calculated as in the following equation [9]:

$$N\% = \frac{\text{Volume of acid by titration} \times \text{acid standard} \times 14 \times \text{dilution volume}}{\text{volume of sample taken upon distillation} \times \text{Weight of digested sample} \times 1000} \times 100$$

Phosphorus% : The phosphorus content in the grains was estimated using ascorbic acid and ammonium molybdate, using a UV-visibleSpectrophotometer at a wavelength of 620 nm [9].

Potassium% : The potassium content in the grains of corn plants was estimated using a Flame photometer [10].

Protein % in the grains: The protein content in the grains was extracted by estimating nitrogen according to the following equation: Protein = Nitrogen % × 6.25 [11].

Oil %: Oil content %: The oil content in the grains was estimated by taking a sample of 5 g for each treatment and from it the oil was calculated using the Soxhlet apparatus and petroleum ether solvent after heating at a temperature of 60-40, according to the method described by[12].

Oil %= (weight of the flask after extraction - its weight before extraction/ weight of the sample) × 100

Statistical analysis

The data were analyzed statistically using analysis of variance and according to the randomized complete block design RCBD for factorial experiments, and the arithmetic means of the treatments were compared using the least significant difference test L.S.D at a probability level of 0.05 using the statistical analysis program 12 Genstate [13].

Results and Discussion

Nitrogen content of grains (%)

The results of Table (2) indicated that there were significant differences in the nitrogen content of grains when adding seaweed fertilization treatments, as treatment A3 gave the highest average nitrogen content of grains, reaching 1.4533%, while the comparison treatment A0 gave the lowest average, reaching 1.2300%, with an increase rate of 22.33%. This increase in concentration and the amount of nitrogen absorbed by the plant may be attributed to the availability of nitrogen in the soil, which leads to increased growth of the root system and increased absorption as a result of adding seaweed fertilizers that contain amino acids and growth regulators that stimulate nitrogen absorption and increase its concentration in leaves and grains [14].

The data of the same table indicated that the concentrations of foliar spraying with Tecamin Max had a significant effect among the foliar spraying concentrations. Treatment N3 gave the highest average of 1.4242%, while the comparison treatment gave the lowest average for this trait of 1.3008%, with an increase rate of 12.34%. The reason for this increase may be due to the fact that the foliar spray fertilizer Tecamin Max contains many important compounds, including amino acids and organic materials, in addition to a percentage of nitrogen, which is absorbed by the leaves, thus increasing its concentration within the tissues of both the leaves and the grains. This is consistent with what was found by [15] . who indicated the role of nitrogen in increasing the plant's content of this element. These results are consistent with what was found by [16].

As for the interaction, it is clear from Table (2) that there is no significant interaction between the treatments of soil fertilization with seaweed and the concentrations of foliar spraying with Tecamin Max, meaning that the effect of the study factors was individual.

Table (2): The effect of fertilization with seaweed and spraying with Tecamin Max and their interaction on the nitrogen%

Seaweed treatments	Foliar spray concentrations of Tecamin Max ml liter-1				Seaweed treatments Means
	N0	N1	N2	N3	
A0	1.1800	1.2033	1.2400	1.2967	1.2300
A1	1.2733	1.2667	1.3300	1.3867	1.3142
A2	1.3133	1.3433	1.3332	1.4767	1.3667
A3	1.4367	1.3767	1.4633	1.5367	1.4533
Tecamin means	1.3008	1.2975	1.3417	1.4242	
L.S.D 0.05	Seaweed	Tecamin	Interaction Seaweed ×Tecamin		
	0.0474	0.0474	N.S		

Grain phosphorus content (%)

It is clear from Table (3) that there are significant differences between the treatments of ground fertilization with seaweed, as treatment A3 gave the highest average of 0.555%, while the comparison treatment gave the lowest average of 0.399%. From the same table, it was found that there was a significant effect between the concentrations of foliar spraying with Tecamin Max, as the N3 treatment gave the highest average of phosphorus percentage in the leaves, which amounted to 0.512%, while the comparison treatment gave the lowest average of 0.465%. The reason for this increase in the percentage of phosphorus and its accumulation in corn grains may be due to the fact that soil fertilization with seaweed or even spraying with amino acids enhanced the accumulation of phosphorus in the leaves and grains, and improved its absorption rates in the grains [16], which is consistent with what was found by [17] and [18]. As for the interaction between the two factors in Table (3), there was no significant effect of the interaction between the two study factors.

Table (3): Effect of fertilization with seaweed and spraying with Tecamin Max and their interaction on phosphorus (%)

Seaweed treatments	Foliar spray concentrations of Tecamin Max ml liter-1				Seaweed treatments Means
	N0	N1	N2	N3	
A0	0.373	0.390	0.410	0.423	0.399
A1	0.427	0.447	0.497	0.530	0.475
A2	0.533	0.533	0.553	0.533	0.538
A3	0.527	0.573	0.557	0.563	0.555
Tecamin means	0.465	0.486	0.504	0.512	
L.S.D 0.05	Seaweed	Tecamin	Interaction		

			Seaweed ×Tecamin
	0.059	N.S	N.S

Potassium content of grains (%)

The results of Table (4) showed significant differences in potassium content (%) when adding seaweed fertilization treatments, as treatment A3 recorded the highest average of 0.4250%, while the comparison treatment A0 recorded the lowest average of 0.3692%. These results are consistent with what was found by [19]. The results of the same table showed significant differences between the concentrations of foliar spraying with Tecamin Max, as treatment N3 recorded the highest average of 4.158%, while the comparison treatment gave the lowest average of 0.3708%. This superiority in the percentage of potassium in the grains may be due to the role of the compound as a good carrier of nutrients, including potassium, which increases the speed of their movement and entry into the plant. Also, the deficiency of some elements (such as calcium or magnesium) may make the plant absorb more potassium [20], which is consistent with what was mentioned by [21]. As for the interaction between the two factors in Table (4), there is no significant effect.

Table (4): The effect of ground fertilization with seaweed and spraying with Tecamin Max and their interaction on potassium %

Seaweed treatments	Foliar spray concentrations of Tecamin Max ml liter-1				Seaweed treatments Means
	N0	N1	N2	N3	
A0	0.3467	0.3800	0.3933	0.3567	0.3692
A1	0.3800	0.4000	0.4133	0.4200	0.4033
A2	0.3667	0.3900	0.4167	0.4333	0.4017
A3	0.3900	0.4200	0.4367	0.4533	0.4250
Tecamin means	0.3708	0.3975	0.4150	0.4158	
L.S.D 0.05	Seaweed	Tecamin	Interaction Seaweed ×Tecamin		
	0.0365	N.S	N.S		

Protein content of grains(%)

The results of Table (5) show that there are significant differences when adding seaweed fertilization treatments, as treatment A3 recorded the highest average of 9.083%, while the comparison treatment A0 recorded the lowest average of 7.687% and an increase rate of 1.39%. The reason for this increase in the percentage of protein in grains may be attributed to the increase in the concentration of nitrogen available in the added

seaweed fertilizer, which means an increase in the chlorophyll content of the leaves, which results in an increase in the carbon metabolism process and thus an increase in protein synthesis [22].

The results of the same table indicated significant differences between the concentrations of foliar spray with Tecamin Max, as the N3 treatment gave the highest average of 8.901%, while the comparison treatment gave the lowest average of 8.130%. With an increase rate of 77.1%. This superiority in the percentage of protein in grains may be attributed to the availability of amino acids and nitrogen in this compound, which was reflected in the increase in protein concentration as a result of the existence of a direct relationship between them, in addition to the fact that nitrogen enters into the composition of chlorophyll and the manufacture of amino acids, which are the basis for the formation of proteins and then their increase in grains [2].

This is consistent with what was mentioned by [5], who referred to the role that nitrogen plays in the composition of nitrogenous bases, which are one of the factors in building nucleic acids that increase the protein content in the plant. Regarding the interaction, it is clear from Table (5) that there is no significant interaction between the treatments of soil fertilization with seaweed and foliar spraying with Tecamin Max, meaning that the effect of the factors was individual.

Table (5): The effect of fertilization with seaweed and spraying with Tecamin Max and their interaction on protein % in grains

Seaweed treatments	Foliar spray concentrations of Tecamin Max ml liter-1				Seaweed treatments Means
	N0	N1	N2	N3	
A0	7.375	7.521	7.750	8.104	7.687
A1	7.958	7.917	8.313	8.667	8.214
A2	8.208	8.396	8.333	9.229	8.542
A3	8.979	8.604	9.146	9.604	9.083
Tecamin means	8.130	8.109	8.385	8.901	
L.S.D 0.05	Seaweed	Tecamin	Interaction Seaweed ×Tecamin		
	0.592	0.592	N.S		

Oil percentage in grains (%)

The results of Table (6) showed significant differences between the treatments of soil fertilization with seaweed, as treatment A3 gave the lowest average of 2.869%, while the comparison treatment A0 recorded the highest average of 4.212% and an increase rate of 1.34%. The increase in the addition of seaweed and the elements and

organic materials it contains led to supporting the construction of these tissues at the expense of the oil percentage in the grains, and the increase in the number of grains per plant resulting from the increase in fertilization levels may be a reason for the decrease in the oil percentage due to the negative relationship between the number of grains per plant and the oil percentage. These results are consistent with what was mentioned by [23,24].

The results of the same table showed that the concentrations of foliar spray with Tecamin Max had a significant effect on the percentage of oil in corn grains. It was found that the comparison treatment N0 gave the highest average of 3.687%, while the spray concentration N3 gave the lowest average of 3.378%, with an increase rate of 30.09%.

As for the interaction, the results of Table (6) showed that there was no significant effect of the interaction between the treatments of soil fertilization with seaweed and foliar spraying with Tecamin Max on the percentage of oil in corn leaves, meaning that the direction of the effect between the study factors was individual.

Table (6): Effect of fertilization with seaweed and foliar spraying with Tecamin Max and their interaction on oil %

Seaweed treatments	Foliar spray concentrations of Tecamin Max ml liter-1				Seaweed treatments Means
	N0	N1	N2	N3	
A0	4.397	4.227	4.137	4.087	4.212
A1	3.827	3.737	3.587	3.640	3.697
A2	3.560	3.447	3.350	3.033	3.347
A3	2.967	2.940	2.820	2.750	2.869
Tecamin means	3.687	3.588	3.473	3.378	
L.S.D 0.05	Seaweed	Tecamin	Interaction Seaweed ×Tecamin		
	0.156	0.156	N.S		

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