Effect of nitrogen fertilizer fractionation, adding organic biofertilizer, and their interaction on some vegetative growth traits of corn

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Abstract

The experiment was conducted in one of the private farmers' farms in Al-Watifiah area affiliated to Al-Iskandariya district / Babylon province from July 2024 until November in loam soil for planting corn (Zea Mays L.) Furat variety. With the aim of knowing the effect of nitrogen fertilizer fractionation and organic biofertilization on soil properties and growth and yield of corn (Furat variety). Using a factorial experiment according to the Randomized Complete Block Design (R.C.B.D), the experiment included two factors. The first factor is nitrogen fertilizer: Urea fertilizer was divided into fifteen parts after (15, 30, 45, 60) and their interactions from the day of planting. As for the second factor, organic biofertilizer: It will be used at two levels (without addition, 1000 kg ha-1) mixed with the soil before planting. The arithmetic means were compared by the least significant difference (LSD) test, at the significance level (0.05). The results of the experiment showed that the nitrogen fertilizer fractionation had a significant effect on all the studied traits including plant height (210.00 cm), leaf area (288.13 cm2) and dry weight of the vegetative growth (403.05 g dry matter. plant-1). Also, the addition of organic biofertilizer led to a significant increase in the studied traits plant height (186.37 cm), leaf area (251.73 cm2) and dry weight of the vegetative growth (500.97 g dry matter. plant-1.(

Introduction

Iraqi soils generally suffer from high soil reaction rate, high calcium carbonate content and low organic matter content. This leads to a decrease in the availability of nutrients alavailable present in the soil and low efficiency of using added mineral fertilizers, especially nitrogen fertilizers, as they are exposed to problems of (sedimentation and adsorption) and their transformation into low-soluble compounds that are not available for absorption by the plant [7]).Urea fertilizer is the most nitrogen-preparing fertilizer in the soil and the most widely used in the world due to its high nitrogen content (46%) and low production costs [23] . The hydrolysis of the amide molecule present in urea fertilizer by the effect of the urease enzyme secreted by soil microorganisms affects the amount of nitrogen lost from the fertilizer through nitrate washing, ammonia evaporation or other biological processes, which reduces the efficiency of nitrogen use in the soil [4,19]. Due to the large expansion in the use of this fertilizer and to contribute to the development of nitrogen utilization efficiency from fertilizer, several methods have been developed to reduce nitrogen loss and increase the efficiency of plant use of nitrogen. These methods include diversifying the methods of addition, finding the appropriate timing for addition, and using slow-release fertilizers [11]. Biofertilizers are one of the complementary sources of chemical fertilizers that include organic fertilizers containing beneficial microorganisms, which leads to an

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increase in crop production (15-50%) when added [17]. Biofertilizers can be an effective way to reduce sources of chemical fertilizers and towards improving soil fertility. This fertilizer improves plant growth by increasing the availability of nitrogen by fixing atmospheric nitrogen and dissolving insoluble mineral phosphorus by producing organic acids and enzymes and organic phosphorus mineral and enhancing root growth[18] The use of biofertilizers in agriculture and their use by farmers is still below the required level despite their importance and the results that encourage their use. Iraq is like most third world countries, where the use of these fertilizers is still below the required level.

Corn (Zea mays) is one of the most important field crops that play a role in the food industry, as its grains are characterized by their high content of starch and oil, in addition to salts, minerals and vitamins, especially vitamin A, which is estimated to be twenty times higher than that of wheat grains. These vitamins are essential in the manufacture of livestock feed and providing essential amino acids for animal growth[1 ,13] In Iraq, the production of corn for the two seasons (spring and autumn) was estimated at (374.4) thousand tons for the cultivated area of (325.9) thousand dunums, and the average yield per dunum for the two seasons (spring and autumn) for the cultivated area was estimated at (1148.8) kg dunum-1 [12]. The study aims to:

.1Study the effect of nitrogen fertilizer fragmentation on some vegetative growth traits and the growth and yield of corn. 2. Knowing the effect of organic biofertilizer on the traits of vegetative growth and growth and yield of corn.

.3Studying the joint combinations between organic biofertilizer and nitrogen fertilizer on some traits of vegetative growth and growth and yield of corn.

Materials and methods

The experiment was conducted on 2024\7\27 in a mixed soil, where a soil sample was taken before planting, brought from the surface horizon 0-30 cm to one of the farmers' fields - Alexandria / Babylon area to determine some chemical and physical traits as in (Table 1), plowing, smoothing and leveling of the soil were conducted , and then the experimental soil was divided into three sectors (replicates) and each sector was divided into 30 experimental units. The dimensions of the experimental unit were (2*3) m, and the distance between the sectors was left with a width of 1 m, and a distance of 1 m was left between the experimental units. The experiment included the following factors: The first factor: Urea fertilizer (N), and the second factor: Biofertilizer (B), as corn seeds of the Furat variety were planted manually at a rate of 3 seeds per hole. After a week of germination, the number of plants was reduced to one plant per hole and the weeds were eliminated by hand weeding whenever necessary. The corn stem borer (Sesamia cretica) was controlled using granular diazinon pesticide at a concentration of 10% (5 kg ha-1) in three batches. The first control was after (20) days of germination and the second batch after 10 days of the first control. The third control was after (25) days of the second control at a rate of three grains in the heart of the plant. Urea fertilizer was added to the soil fifteen parts after (15, 30, 45, 60) and their interactions from the day of planting and according to the fertilizer recommendation (120 kg N ha-1). [5] According to Table (2). Also, biofertilizers were added to the soil at two levels (0-1000 kg ha-1) and mixed with the soil before planting. According to Table

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(2)The averages of the treatments were compared according to the least significant difference test (LSD) at a probability level of 0.05 [4[

Table (1) Analysis of some chemical, physical and biological properties of the studied soil

traits		values	units
PH		**7.6**	---
Ece		3.4	**dSm^{-1}**
Organic matter		9.8	**$g\ kg^{-1}$**
CEC		21.2	**Centamol charge kg-1 soil**
Positive ions	**Ca^{+2}**	**12.8**	**$MeqL^{-1}$**
	Mg^{+2}	**7.7**	
	K^{+1}	**0.8**	
	Na^{+1}	**8.0**	
Negative ions	**CO_3^{--}**	**NiLL**	
	HCO_3^{-}	**2.6**	
	Cl^{-}	**21.5**	
	SO_4^{--}	**5.2**	
Available Nitrogen		**23.5**	**$mgkg^{-1}$**
Available Phosphorus		**8.8**	
Available Potassium		**183.5**	
Bulk Density		1.4	
Sand		**340**	**gkg^{-1}**
Silt		405	
Clay		255	
Bulk Density		**1.43**	**gm\cm3**
texture		**loam**	

Table (2) Description of the treatments and the amount of fertilizers used in the experiment

Symbol treatments	**Amount of fertilizer added kg ha^{-1}**	**treatments**	**No.**
N1	120	After 15 days of planting	1
N2	120	After 30 days of planting	2
N3	120	After 45 days of planting	3
N4	120	After 60 days of planting	4
N5	60+60	After 15+ 30 days of planting	5
N6	60+60	After 15+ 45 days of planting	6
N7	60+60	After 15+ 60 days of planting	7
N8	60+60	After 30+ 45 days of planting	8
N9	60+60	After 30+ 60 days of planting	9
N10	60+60	After 45+ 60 days of planting	10
N11	40+40+40	After 15+ 30+ 45 days of planting	11
N12	40+40+40	After 15+ 30+ 60 days of planting	12
N13	40+40+40	After 15+ 45+ 60 days of planting	13
N14	40+40+40	After 30+ 45+ 60 days of planting	14
N15	30+30+30+30	After 15+ 30+ 45+ 60 days of planting	15

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Studied Traits

-1Plant Height (cm(

.1Plant Height (cm): Ten plants were taken randomly from each experimental unit using a measuring tape graduated in centimeters from the first stem node close to the soil surface until the end of the male inflorescence [8.[

-3Leaf Area (cm2(

Leaf Area (cm plant): The length of the leaf located under the main ear of the plant was measured at the flowering stage and the following equation was applied

Leaf Area of the Plant - Square of the length of the leaf under the ear × 0.75 for the plant that bears 14 leaves or more, and multiplied by the constant 0.65 for the plant that bears 13 leaves or less [9[

-3Dry Weight of the Vegetative growth

Plants were taken from each experimental unit randomly, at a rate of one plant from each side of the plantation at the end of the season, then dried in an electric oven at a temperature of 65°C until the weight was constant, and the dry weight of each experimental unit was measured.

Chemical Analysis Soil physical properties before planting

-1Estimation of soil particle size distribution

The sizes of soil particles will be estimated using the hydrometer method according to [16.[

-2Electrical conductivity EC

The electrical conductivity in the 1:1 soil extract will be measured using the EC-meter according to [16.[

-3Soil reaction pH

The soil reaction degree in the 1:1 soil extract will be measured using the pH-meter according to [16.[

-4Cation exchange capacity CEC

It will be estimated using ammonium acetate solution (1M) according to [16.[

-5Percentage of organic matter in the soil

The organic matter in the soil will be estimated by titrating the oxidized organic carbon with ammonium ferrous sulfate according to the Walkley and Black method mentioned by [16.[

-6Soluble calcium

The soluble calcium will be estimated in the 1:1 soil extract by titration with ferrous sulfate (Na2EDTA) using Ammonium Purpurate reagent according to [21.[

-7Soluble magnesium: Calcium and magnesium will be estimated using the (EBT) reagent and titration with ferrous sulfate, subtracting calcium from the total calcium and magnesium according to [21.[

-8Soluble potassium

It will be estimated in the 1:1 soil extract using the FlamePhotomere device according to [21.[

9-Sulphates

Sulphates will be estimated by turbidity method using barium chloride, then measured by Spectrophotometer according to [16.[

-10Carbonates and bicarbonates

They will be estimated in the 1:1 soil extract using the titration method with dilute sulfuric acid concentration 0.01N according to [21.[

-11Available nitrogen

Available nitrogen extracted with KCl (2N) solution will be estimated using Microkjeldahl apparatus, ammonium was reduced using MgO and nitrate ion using Devarda alloy according to the method of [16.[

-12Available phosphorus

Available phosphorus extracted with sodium bicarbonate solution (0.5M) will be estimated according to the Olsen method, measured

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using a (Spectro photometer) at a wavelength of 882 nm according to [16.[

-13Available potassium

Available potassium extracted with calcium chloride (0.5M) will be estimated, measured using a (Flame Photometer) according to the method [16.[

Results and Discussion

4-4Effect of nitrogen fertilizer fractionation and addition of organic fertilizer and their interaction on growth traits

1-4-4Plant height (cm(

It is clear from the results of Table (3) for the effect of the studied factors on plant height that the organic fertilizer treatment (1000 gave the highest rate and reached 199.22 cm, while the lowest rate (0) recorded the lowest rate for plant height, reaching 182.00 cm.The table indicates that the urea addition treatments have a significant effect on plant height, as the N15 treatment (after 15+30+45+60 days of planting) was significantly excelled and recorded the highest plant height rate of 186.37 cm, while the comparison treatment N1 after (15 days of planting) recorded the lowest plant height rate of 174.87 cm. Bi-interaction treatment between biofertilization and urea addition treatments showed a significant effect on plant height, as the interaction treatment (N15B2) was significantly excelled and recorded the highest plant height rate of 210.00 cm, while the comparison treatment (N1B2) recorded a plant height of 192.1 cm.

Table (3) Effect of nitrogen fertilizer fractionation, adding organic biofertilizer and their interaction on Plant height (cm).kg.h-1)

	N15	N14	N13	N12	N11	N10	N9	N8	N7	N6	N5	N4	N3	N2	N1	N
182.00	186.37	185.77	185.50	185.10	184.30	184.03	183.63	182.90	182.37	180.47	180.23	179.37	178.17	177.00	174.87	B1
199.22	210.00	206.93	205.97	204.87	202.23	200.83	199.83	198.13	197.37	195.10	194.10	193.80	193.67	193.37	192.10	B2
	198.18	196.35	195.73	194.98	193.27	192.43	191.73	190.52	189.87	187.78	187.17	186.58	185.92	185.18	183.48	
AB	0.43273		B	0.306				A	0.1117		LSD					

Leaf area (cm2(

The results of table (4) for the effect of the studied factors on leaf area showed that the treatment of organic biofertilizer (1000 kg.h-1) gave the highest average and reached 271.18 cm2 cm, while the lowest average (0) recorded the lowest average for leaf area, reaching 235.83 cm2.The table indicates that the urea addition treatments had a significant effect on leaf area, as the N15 treatment (after 15+30+45+60 days of planting) was significantly excelled and recorded the highest average for leaf area, 251.73 cm2, while the comparison treatment N1 recorded the lowest average for leaf area, 213.77 cm2 after (15 days of planting.(

The treatment of bi-interaction between biofertilization and urea addition treatments showed a significant effect on the leaf area, as the interaction treatment (N15B2) was significantly excelled and recorded the highest average leaf area of 288.13 cm2, while the comparison treatment (N1B2) recorded a leaf area of 235.83 cm2.

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Table (4) Effect of nitrogen fertilizer fractionation, organic fertilizer addition and their interaction on leaf area (cm2.(

	N15	N14	N13	N12	N11	N10	N9	N8	N7	N6	N5	N4	N3	N2	N1	N
235.83	251.73	248.27	247.33	247.13	244.60	242.83	242.50	241.30	233.47	230.50	227.77	224.43	222.50	219.37	213.77	B1
271.18	288.13	281.40	280.30	279.60	271.17	270.07	269.60	268.70	268.10	266.70	266.20	265.63	265.20	264.47	262.50	B2
	269.93	264.83	263.82	263.37	257.88	256.45	256.05	255.00	250.78	248.60	246.98	245.03	243.85	241.92	238.13	
AB	0.35218		B	0.249			A	0.091			LSD					

Dry weight of the vegetative group (gm dry matter.plant-1(

The results of Table (5) for the effect of the studied factors on the dry weight of the vegetative group showed that the treatment of organic biofertilizer (1000 kg.ha-1) gave the highest average and reached 475.08 gm dry matter.plant-1 cm, while it recorded the lowest average (0) The lowest average dry weight of the vegetative group reached 363.02 gm dry matter.plant-1. The table indicates that the urea addition treatments have a significant effect on the dry weight of the vegetative group, as the N15 treatment (after 15 + 30 + 45 + 60 days of planting) was significantly excelled and recorded the highest average dry weight of the vegetative group 403.05 g dry matter. plant-1, while the comparison treatment N1 after (15 days of planting) recorded the lowest average dry weight of the vegetative group 319.4 g dry matter. plant-1.Bi-interaction treatment between biofertilization and urea addition treatments showed a significant effect on the dry weight of the vegetative group, as the interaction treatment (N15B2) was significantly excelled and recorded the highest average dry weight of the vegetative group amounting to 500.97 g dry matter. plant-1, while the comparison treatment (N1B2) recorded the dry weight of the vegetative group amounting to 448.19 dry weight of the vegetative group.

Table (5) Effect of nitrogen fertilizer fractionation, addition of organic biofertilizer and their interaction on the dry weight of the vegetative growth (g dry matter.plant-1(

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	A
363.02	403.05	390.47	389.34	387.69	380.81	379.33	377.12	371.50	351.13	348.25	345.07	340.06	332.84	329.27	319.40	a1
475.08	500.97	490.91	490.56	489.36	484.50	481.21	479.67	476.51	469.44	466.03	465.24	463.45	461.48	458.65	448.19	a2
	452.01	440.69	439.95	438.53	432.66	430.27	428.40	424.00	410.29	407.14	405.16	401.76	397.16	393.96	383.80	
AB	1.8216			B=	1.288				A=	0.4703	LSD					

The results shown in Tables (3-5) showed a significant increase in some vegetative growth traits (plant height, leaf area, dry weight of the vegetative system). This is attributed to the role of biofertilizers in improving vegetative growth and increasing the surface area of the absorption area, which in turn increased the rate of water and nutrient absorption by the plant, as well as its role in secreting some hormones in the rhizosphere and some mono- or dicarboxylic organic acids, which affects

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the pH values around the root zone, which helps in the readiness of the elements, the most important of which is phosphorus, and activating the root system and root hairs with a large area. This led to an increase in the vegetative growth of the plant. These results are consistent with [1,20,22[

Also, adding this organic fertilizer may be due to its containing organic acids such as humic and fulvic as well as most of the major and minor elements, as well as the fact that one gram contains 20,000,000 beneficial microorganisms that play different roles, including nitrogen fixation, phosphorus and potassium release, and chelation of minor elements, which are stimulating and encouraging factors for the reproduction and growth of organisms that secrete organic acids and stimulating hormones such as auxins and gibberellins that stimulate the growth and elongation of stem cells and increase the height of the plant, as well as the activity of microorganisms in increasing the rate of plant height through their important role in increasing and preparing nutrients in the soil and stimulating the plant to produce plant hormones, especially auxins, and their important role in increasing the height[14,24. [

The addition of nitrogen fertilizer led to an increase in the building process in addition to its role in building chlorophyll, which led to an increase in the growth rate represented in the leaf area [7]. The increase in plant height, leaf area, and dry weight of the green mass of the corn plant is attributed to increased root penetration, which leads to an increase in dry weight, plant length, and leaf area, as this trait is affected by environmental factors and balanced N supply, which contributes to increasing the solubility and availability of phosphorus [6]. The plant height increased with increased nitrogen fertilization. The entry of nitrogen and phosphorus into the structure of most cell membranes in plant tissue increases, especially chloroplasts, enabling the plant to perform high net photosynthesis, which increases the rate of production of carbon skeleton materials, which is the basic building block of the green group [3] . Nitrogen is a vital element for plant growth and development among all required nutrients. This element plays a major role in most metabolic processes of plants. It is also one of the main components of the chlorophyll structure in plants. Chlorophyll content and nitrogen content in plants are closely related. Chlorophyll content plays a vital role in determining the rate of photosynthesis and production in plants. Nitrogen content in leaves increases when nitrogen fertilizer is added. The high nitrogen content in leaves is associated with the high chlorophyll content and increased activity of chloroplasts, thus increasing the productivity of photosynthesis [10]. The addition of mineral fertilizer increased the availability of nutrients in the soil, which led to the formation of a good and efficient root system capable of absorbing nutrients and transporting them to the upper parts, which was positively reflected in the dry weight of the plant[15[

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