# Effect of spraying stages with bio-organic and nano-fertilizers on the growth and yield of maize (Zea mays L(.

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**Abstract**

A field experiment was conducted in Babylon province / Al-Mussaib project during the 2023 agricultural season to study the effect of bio and organic fertilization and nano-fertilizer spraying stages on Maize. It was applied as a split-split plot experiment according to the R.C.B.D. complete randomized block design with three factors. The main plots included three different stages of spraying of balanced nano-fertilizer NPK (20:20:20) with a concentration of (2) g.L-1, sprayed on the vegetative parts of the plants after one month of planting the seeds. The sub-plots included four levels of organic matter (control treatment, cow waste 8 tons. ha-1, palm frond waste 8 tons. ha-1, cow waste mixture 4 tons. ha-1 + Palm frond waste 4 tons ha-1, the sub-sub-plots included four levels of biofertilizer with the control treatment, without biofertilization (control), fungal biofertilization (Mycorrhizae: Glomus mosseae), and bacterial biofertilization: which are A mixture of three types of bacteria: (Azotobacter chroococcum, Bacillus mucilaginosus, Pseudomonas fluorescens), a mixture of (fungal biofertilization + bacterial biofertilization). The results showed the superiority of the triple(A3B1C3) interaction of the combination consisting of (spraying stage (S8+S10) with the addition of 8 tons of cow waste ha-1 with the addition of the treatment (bacteria + fungus from the biofertilizer) significantly increased the vegetative growth and yield components traits and gave the highest average in the Number of cobs (1.98 cob. Plant-1), weight of 500 grain (167.81 g), yield of one plant (186.18 g) and grain yield (9.930 tons. h-1).The study concluded that bio and organic fertilization, either alone or in combination, can stimulate microbial activity and increase the availability of nutrients in the soil, and that the use of bio and organic fertilizers + nano-fertilizers can be used as an alternative fertilizer to reduce the consumption of chemical fertilizers.

**Keywords**: nano-fertilizer, bio fertilizer, organic fertilizer, Maize

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## Introduction

Maize (Zea mays L.) is a field crop belonging to the Poaceae family, and one of the main crops in the world for feed, food, and industrial use. It is native to Central America and ranks third in terms of importance among crops in the world [17] Its grains contain a high percentage of starch, about 72%, proteins 10%, oils (4-8%), fiber (8-5%), sugars 3%, and ash 1.7% [11]The use of organic fertilizer sources from natural organic sources, whether plant or animal, improves soil fertility and crop yields. [5,6,22] The general trend towards clean agriculture has necessitated the consideration of alternatives, including the use of nano-fertilizers to increase the productivity of field crops, as they contain micro- and macro-nutrients, amino acids, and organic carbon. Their use has effects on vegetative growth indicators and yield for many plants at different stages of their growth, as they

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contain the important nutrients for germination [19] Biofertilizer is a material that contains beneficial microorganisms for plant growth and development. Different mechanisms are used by bacterial strains in order to enhance nutrient uptake, improve soil fertility, and increase crop yields by fixing nitrogen, dissolving potassium and phosphorus, secreting plant hormones, and producing substances that inhibit plant pathogens. [15.[

Material and Methods

The field experiment was conducted in Babylon province / Al-Mussaib project during the 2023 agricultural season Random samples were taken from six different sites of the experimental soil at a depth of 0-30 cm. Then, the samples were mixed together and analyzed for some physical and chemical properties of the field soil (Table 1) at the laboratory complex of the Najaf Agriculture Directorate. The experimental field was ploughed twice at right angles, then it was smoothed and leveled and divided into rows with a distance of 75 cm between each row and 25 cm between each plant. The area of the experimental unit was (3 m x 2 m). A distance of 2 m was left between the replicates and 1 m between the experimental units, which totaled 144 experimental units. The seeds were sown in the form of rows, with each experimental unit containing 4 rows, each of which contained 8 plants. The total number of plants in each experimental unit was 32. Levels of decomposed organic matter from cattle manure and palm fronds were added to the soil one week before sowing. The seeds were sown on July 14, 2023, , at a rate of two seeds per hole at a depth of (2-3) cm and a plant density of 53.333 plants.ha-1. Levels of biofertilizer were also Loaded the vaccine on the sterilized Peat Moss and added at a rate of (10 g) per hole with the seeds. The spore strength of the fungus was (60 spores. g-1) and the strength of the bacterial vaccine was (1.3 * 10^10 cells/ml), (2.5 * 10^9 cells/ml), (1.5 * 10^9 cells/ml) Respectively, and was thinned to one plant after 15 days of planting. Then, the balanced nano-fertilizer was sprayed after 30 days of planting, with a total of 4 sprays on the vegetative growth of the plants throughout the growing season of maize in the (four, six, eight, and ten) leaves stage, i.e. after (30,37,44,51) days of planting. Two sprays of the nano-fertilizer were applied for each level using a 20-liter backpack sprayer until the vegetative growth was completely wet, taking care that the spray was done in the early morning to avoid high temperatures and drying of the solution on the plant. The harvesting process was carried out at the final maturity stage, which is the appearance of the final maturity signs, which are yellowing and drying of the leaves and stems, the integration of the growth of the cobs, and the appearance of the black scar at the base of the grain when it is removed from the cob. With three factors :

Main plot: included three stages of nano-spraying: spraying the neutral nano-fertilizer NPK (20:20:20) at a concentration of (2) g.L-1, Two applications of spray were applied to the vegetative growth of the plant at different stages of its growth.

)A1) : (S4+S10) , (in four-leaf stage + in ten-leaf stage(

)A2) : (S6+S10, ((in six -leaf stage + in ten-leaf stage(

)A3 : ((S8+S10), (in eight -leaf stage + in ten-leaf stage(

Sub plot: it included three concentrations of organic matter with control treatment (control treatment, (cow waste 8 tons. ha-1), (palm frond waste 8 tons. ha-1), (cow waste mixture

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4 tons. ha-1 + Palm frond waste 4 tons ha-1) symbol B0,B1,B2,B3 Added to the soil one week before agriculture .

Sub sub plot: included three levels of biofertilizer with the control treatment, without biofertilization(control), fungal biofertilization (Mycorrhizae: Glomus mosseae), and bacterial biofertilization: which are A mixture of three types of bacteria: (Azotobacter chroococcum, Bacillus mucilaginosus, Pseudomonas fluorescens),a mixture of (fungal biofertilization+ bacterial biofertilization). The biofertilizer was Loaded the vaccine on the sterilized Peat Moss and added at a rate of (10 g) in each hole with the seeds. The spore strength of the fungus was (60 spores. g-1) and the strength of the bacterial vaccine was (1.3 * 10^10 cells/ml), (2.5 * 10^9 cells/ml), (1.5 * 10^9 cells/ml) Respectively

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**Table 1. Physical and chemical traits of field soil at a depth of (0-30) cm**

| Soil separators | | | | PH | EC | Available nitrogen | Available phosphorus | Available potassium | Organic matter |
|---|---|---|---|---|---|---|---|---|---|
| Clay | Silt | Sand | Texture | | | | | | |
| **7.5** | **72.5** | **20** | Silt Loam | **7.6** | **3.1** | **33.2** | **7.6** | **126** | **1.1** |
| **%** | **%** | **%** | | **-** | $DS.m^{-2}$ | $mg.kg^{-1}$ | $mg.kg^{-1}$ | $mg.kg^{-1}$ | $mg.kg^{-1}$ |

* Najaf Agriculture Directorate/Laboratory Complex

Studied traits

Number of cobs (cob. Plant-1), weight of 500 grain (g), yield of one plant (g(,grain yield (tons. h-1(

Statistical Analysis:

The results were analyzed using the statistical program (GenStat 12.1) and the average means were compared based on the least significant difference (LSD) at a significance level of( 0.05) to find the differences between the average means of the treatments.

Results and Discussion

Number of cobs (cob. Plant-1(

The results in Table (2) indicate that the spraying stage (S8 + S10) was significantly excelled on the spraying stage (S4 + S10) and in terms of Number of cobs , as it achieved the highest rate of 1.64 cob. Plant-1, While the spraying phase (S4 + S10) gave an average of 1.54 cob. Plant-1. There were no moral differences with the spraying phase (S6 + S10), which gave an average of 1.58 cob. Plant-1. The reason for the superiority of the nano-balanced fertilizer can be attributed to the availability of nutrients, including nitrogen and potassium, which contribute to the increase in carbon fixation and the transport of the products from the plant in the leaves to the outlet in the cobs. [9]The results in Table (2) showed that the addition of organic matter had a significant effect on the Number of cobs trait , where the results indicated that the addition (B1) (cow waste 8 tons. h-1) was significantly excelled on the rest of the concentrations used in the experiment (the control treatment and The addition is 8 tons.ha-1 of palm frond waste and the addition is 4 tons.ha-1 of palm frond waste + 4 tons/h-1 of cow waste) achieving the highest rate for this traits of 1.70 cob. Plant-1. The lowest rate was achieved when the control treatment (B0) was achieved.

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It gave the lowest rate of 1.42 cob. Plant-1. The reason may be that organic manure is able to support plant growth, nutrient absorption and increased soil fertility [4] Thus an increase in the radical and vegetative growth of plants is clearly reflected in the increase in the period of male and female flowering and thus in the increase in the Number of cobs. The results are consistent with [14] The results in Table (2) showed that adding biofertilizer to the soil caused a significant increase in the Number of cobs trait , as the addition (C3 bacteria + fungi) achieved a significantly excelled over the additions used in the experiment (control treatment, the C1 addition, and the C2 addition) by achieving the highest rate for the trait. It was 1.80 cob. Plant-1, while control treatment gave the lowest average for the trait, which was 1.34 cob. Plant-1, respectively. The reason for the superiority when adding the biofertilizer can be attributed to the role of the fertilizer in increasing the availability of essential nutrients in increasing the duration of male and female flowering, which leads to an increase in the rate of node formation, which leads to an increase in the number of cobs. Biofertilizer also works to increase the concentration of growth regulators such as auxin and cytokinins that encourage flowering growth and reduce flower drop in addition to good supply of nutrients that reflect on the flowering and yield traits [22] This is what[7] confirmed that the use of biofertilizers from (mycorrhizal fungus of the genus Glomus mosseae) on yellow corn plants led to a significant increase in yield and its components

**Table (2) The effect of biological and organic fertilization and the stages of nano-fertilizer application and their interaction on Number of cobs (cob. Plant$^{-1}$)for autumn season of 2023.**

| B × A | Biofertilization (C) | | | | Organic fertilization tons.h$^{-1}$ (B) | stages of spraying nanofertilizer (A) |
|---|---|---|---|---|---|---|
| | C3 | C2 | C1 | C0 | | |
| 1.39 | 1.57 | 1.40 | 1.40 | 1.20 | B0 | S4+S10 |
| 1.65 | 1.87 | 1.80 | 1.60 | 1.33 | B1 | |
| 1.56 | 1.77 | 1.67 | 1.53 | 1.27 | B2 | |
| 1.62 | 1.87 | 1.73 | 1.53 | 1.33 | B3 | |
| 1.42 | 1.60 | 1.40 | 1.40 | 1.27 | B0 | S6+S10 |
| 1.70 | 1.93 | 1.80 | 1.67 | 1.40 | B1 | |
| 1.57 | 1.80 | 1.67 | 1.47 | 1.33 | B2 | |
| 1.63 | 1.87 | 1.73 | 1.53 | 1.40 | B3 | |
| 1.45 | 1.60 | 1.47 | 1.40 | 1.33 | B0 | S8+S10 |
| 1.74 | 1.98 | 1.87 | 1.67 | 1.42 | B1 | |
| 1.60 | 1.73 | 1.73 | 1.60 | 1.33 | B2 | |
| 1.69 | 1.92 | 1.83 | 1.60 | 1.40 | B3 | |
| 0.08 | 0.13 = L.S.D 0.05 | | | | | |

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| Average effect (A) | C3 | C2 | C1 | C0 | Biofertilization (C ) / stages of spraying nanofertilizer (A) |
|---|---|---|---|---|---|
| 1.54 | 1.75 | 1.63 | 1.52 | 1.25 | S4+S10 |
| 1.58 | 1.80 | 1.65 | 1.52 | 1.35 | S6+S10 |
| 1.64 | 1.88 | 1.72 | 1.57 | 1.40 | S8+S10 |
| 0.07 | 0.08 | = L.S.D 0.05 | | | |
| Average effect(B) | C3 | C2 | C1 | C0 | Biofertilization(c) / Organic fertilizer (B) |
| 1.42 | 1.58 | 1.42 | 1.40 | 1.29 | B0 |
| 1.70 | 1.95 | 1.82 | 1.64 | 1.38 | B1 |
| 1.57 | 1.75 | 1.67 | 1.53 | 1.31 | B2 |
| 1.65 | 1.91 | 1.76 | 1.56 | 1.36 | B3 |
| 0.04 | 0.07 | = L.S.D 0.05 | | | |
| | 1.80 | 1.67 | 1.53 | 1.34 | Biofertilization (C) |
| | 0.03 | | | | L.S.D 0.05 |

The interaction between the stages of nano-spraying and the addition of organic matter had a significant effect on Number of cobs traits , as the interaction treatment (spraying S8 + S10) with the addition of 8 tons ha-1 of cow manure achieved a significantly excelled on all treatments and gave the highest rate of 1.74 cob. Plant-1, while the interaction treatment (nanospraying stage (S4 + S10) with control treatment) gave the lowest average plant height of 1.39 cob. Plant-1.As for the effect of the interaction between the nano-spray stage and the addition of biofertiliser, the interaction treatment (spray stage S8 + S10) with the addition (C3) bacteria + fungus) achieved significantly excelled in Number of cobs traits over all other interaction in the experiment and gave the highest rate of And 1.88 cob. Plant-1, compared to the interaction treatment (spraying stage (S4 + S10) with control treatment), which gave the lowest trait rate of 1.25 cob. Plant-1. The results of Table (2) showed that the interaction between the addition of organic matter and bio fertilization had a significant effect on Number of cobs traits , as the interaction treatment (adding 8 tons of cow manure with the addition of (C3) bacteria + fungi) achieved the highest rate. In the above trait, it reached 1.95 cob. Plant-1, and thus it was significantly excelled on most the treatments used in the experiment, while (control treatment( B0C0) achieved the lowest average of 1.29 cob. Plant-1.The triple interaction between the study factors had a

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significant effect in achieving the highest rate of Number of cobs traits , as the results showed the excelled of the triple interaction for the combination consisting of (A3B1C3) significantly affected most the interaction treatments in the experiment by achieving the highest rate of 1.98 cob. Plant-1, compared to the triple interaction treatment consisting of the combination (spraying stage (S4 + S10) + treatment B0C0), which recorded the lowest rate of 1.20 cob. Plant-1.

weight of 500 grain (g(

The results in Table (3) showed that the nanospraying stage had a significant effect on weight of 500 grain in the autumn season, where the nanospraying treatment (S8 + S10) was significantly excelled on the spraying treatment (S4 + S10), achieving the highest rate of (155. 29 g) compared to (151.01 g) There were no moral differences with the spraying phase (S6 + S10) . The reason for the superiority can be attributed to the fact that the nano-balanced fertilizer increases the availability of nutrients by increasing the permeability of cell membranes, thus accelerating the absorption of nutrients by the plant and causing an increase in the materials produced during the photosynthesis process and their transfer to the grains. The results agreed with what was reached by [2,12] .The results indicate that organic fertilization differ significantly among themselves in this of the autumn crop, where the addition (cow manure 8 tons. ha-1) has a significant increase on the rest of the concentrations used and gave the highest rate of (158.21g ), while control treatment gave the lowest rate of( 145.56g). This may be due to an increase in the leaf area of the plant and thus an increase in the efficiency of photosynthesis, which has contributed significantly to an increase in the weight of 500 grains, a natural reflection of the plant's increased ability to produce sufficient quantities of processed foodstuffs and transfer its products to grains. [18] Results agreed with [4] The bio fertilization caused a significant increase in the weight

**Table (3) Effect of biological and organic fertilization and stages of nanofertilizer spraying and their interaction on the weight of 500 grain(g) for the 2023 autumn season.**

| B × A | Biofertilization (C) | | | | Organic fertilization tons.h$^{-1}$ (B) | stages of spraying nanofertilizer (A) |
|---|---|---|---|---|---|---|
| | C3 | C2 | C1 | C0 | | |
| 143.68 | 147.48 | 142.85 | 142.45 | 141.92 | B0 | S4+S10 |
| 155.66 | 163.94 | 159.64 | 154.79 | 144.28 | B1 | |
| 153.67 | 161.25 | 157.84 | 152.33 | 143.24 | B2 | |
| 155.03 | 163.40 | 158.59 | 154.12 | 144.01 | B3 | |
| 145.78 | 149.38 | 145.90 | 144.21 | 143.62 | B0 | S6+S10 |
| 158.84 | 166.76 | 163.67 | 157.96 | 146.95 | B1 | |
| 155.51 | 162.82 | 159.81 | 155.08 | 144.32 | B2 | |
| 158.20 | 165.16 | 163.52 | 157.46 | 146.64 | B3 | |
| 147.23 | 152.82 | 146.48 | 145.25 | 144.38 | B0 | S8+S10 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| **160.14** | **167.81** | **163.82** | **159.94** | **148.97** | **B1** | |
| **158.09** | **164.59** | **162.08** | **157.75** | **147.92** | **B2** | |
| **155.70** | **165.99** | **161.76** | **152.11** | **142.95** | **B3** | |
| **2.06** | **2.93** | **= L.S.D 0.05** | | | | |
| **Average effect (A)** | **C3** | **C2** | **C1** | **C0** | **Biofertilization (C ) stages of spraying nanofertilizer )(A )** | |
| **152.01** | **159.02** | **154.73** | **150.92** | **143.36** | **S4+S10** | |
| **154.58** | **161.03** | **158.22** | **153.68** | **145.38** | **S6+S10** | |
| **155.29** | **162.80** | **158.53** | **153.76** | **146.06** | **S8+S10** | |
| **1.17** | **1.67** | **=L.S.D 0.05** | | | | |
| **Average effect(B)** | **C3** | **C2** | **C1** | **C0** | **Biofertilization( C) Organic fertilizer (B)** | |
| **145.56** | **149.89** | **145.07** | **143.97** | **143.30** | **B0** | |
| **158.21** | **166.17** | **162.38** | **157.56** | **146.73** | **B1** | |
| **155.75** | **162.88** | **159.91** | **155.05** | **145.16** | **B2** | |
| **156.31** | **164.85** | **161.29** | **154.56** | **144.53** | **B3** | |
| **0.17** | **0.209** | **= L.S.D 0.05** | | | | |
| | **160.95** | **157.16** | **152.79** | **144.93** | **Biofertilization (C)** | |
| | **0.72** | | | | **L.S.D 0.05** | |

of 500 grain , where the biofertilization treatment (C3) gave a significantly excelled on the other two concentrations by recording the highest rate of (160.95 g), respectively, compared to control treatment, which gave the lowest rate of( 144.93 g). This may be due to the role of bacterial and fungal biosynthesis in increasing nutrient readiness and increasing growth-inducing hormones [13] This can lead to increased leaf area and leaf number, as well as increased weight of 500 grains. This is supported by the findings of[1] who found a significant increase in the weight of 500 grains when using the mixed biofertilizer (Azotovit + phosphatovit) on the maize plant. The interaction between the stages of nano-spraying and organic fertilization (Table 3) showed a significantly excelled , where the interaction treatment (spraying S8 + S10) with the addition of( 8 tons.ha-1 of cow waste) gave the highest rate for this traits, amounting to 160.14 g, thus excelled on most treatments, in While the interaction treatment (nanospraying stage (S4+S10) with control treatment) gave the lowest rate for this trait and amounted to 143.86 g. The bi- interaction between the stages of nanospraying and adding different concentrations of

biofertilization had a significant effect on the weight of 500 grain trait in Table (3). The bi-interaction between (spraying stage S8 + S10) with the addition (C3) bacteria + fungi) gave the highest rate for the above trait and amounted to 162.80g. A leaf, excelled on most the interaction treatments, while the interaction treatment (spraying stage (S4+S10) with control treatment) gave the lowest average for this traits, amounting to 143.36 g. The interaction of different additions of organic fertilization and bio fertilization led to a significant increase in the above trait of autumn seasons, as it was given with The interaction treatment (B1C3) (addition of 8 tons .ha-1 cow manure with the addition of (C3) bacteria + fungi) had a significantly excelled in the number of leaves by giving it the highest average for this trait, amounting to 166.17 g, thus surpassing most treatments compared to control treatment (B0C0), which It gave the lowest average for this trait, which was 143.30 g. Table (3).The triple interaction between the experimental factors showed a significant effect on the number of leaves , as the interaction treatment recorded (spraying stage (S8 + S10) with the addition of 8 tons.ha-1 organic matter with the addition of the treatment (C3) bacteria + fungi from biofertilization ) was significantly excelled on most treatments, as it achieved the highest rate of 167.81 g, compared to the interaction treatment (spraying stage (S4+S10) + treatment B0C0), which achieved the lowest rate of 141.92 g, (Table 3.(

This is supported by the findings of [9]The results in Table (4) indicated that

yield of one plant (g)

The results in Table (4) showed that the nanospraying parameters used in the experiment differed significantly among them in the yield of one plant traits , as the spraying stage (S8 + S10) was significantly excelled on the spraying stage (S4 + S10), recording the highest average of 169.11 g. Compare 164.52 g. There were no significant differences with the spraying stage (S6 + S10), which gave an average of 166.07 g. Nanofertilizers are small enough to be absorbed by plants more easily. They can also provide essential nutrients, such as nitrogen and potassium, which are needed for protein synthesis and enzyme activation. This can lead to increased photosynthetic efficiency and the transport of assimilates from the leaves to the grains.

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**Table (4) The effect of biological and organic fertilization and the stages of nano-fertilizer application and the interaction between them on yield of one plant (g) of 2023**

| B × A | Biofertilization (C) | | | | Organic fertilization tons.h$^{-1}$ (B) | stages of spraying nanofertilizer ) (A |
|---|---|---|---|---|---|---|
| | C3 | C2 | C1 | C0 | | |
| 152.33 | 156.51 | 152.74 | 151.35 | 148.73 | B0 | S4+S10 |
| 170.11 | 181.81 | 175.73 | 169.54 | 153.35 | B1 | |
| 166.98 | 177.56 | 172.19 | 167.02 | 151.15 | B2 | |
| 168.66 | 181.02 | 173.20 | 167.38 | 153.05 | B3 | |
| 153.98 | 158.49 | 154.03 | 152.62 | 150.76 | B0 | S6+S10 |
| 171.71 | 183.69 | 177.64 | 171.36 | 154.16 | B1 | |
| 168.30 | 179.03 | 173.06 | 167.84 | 153.28 | B2 | |
| 170.30 | 184.38 | 174.08 | 168.68 | 154.06 | B3 | |
| 157.72 | 162.47 | 159.22 | 156.76 | 152.42 | B0 | S8+S10 |
| 175.39 | 186.18 | 182.10 | 175.19 | 158.07 | B1 | |
| 170.59 | 180.96 | 175.07 | 170.58 | 155.75 | B2 | |
| 172.73 | 184.31 | 177.38 | 172.82 | 156.42 | B3 | |
| 3.43 | L.S.D 0.053.75 = | | | | | |
| Average effect (A) | C3 | C2 | C1 | C0 | Biofertilization (C ) / stages of spraying nanofertilizer / (A) | |
| 164.52 | 174.22 | 168.47 | 163.82 | 151.57 | S4+S10 | |
| 166.07 | 176.40 | 169.70 | 165.12 | 153.07 | S6+S10 | |
| 169.11 | 178.48 | 173.44 | 168.84 | 155.66 | S8+S10 | |
| 3.23 | L.S.D 0.053.30 = | | | | | |
| Average effect(B) | C3 | C2 | C1 | C0 | Biofertilization) C( / Organic fertilizer (B) | |
| 154.68 | 159.15 | 155.33 | 153.58 | 150.64 | B0 | |
| 172.40 | 183.90 | 178.49 | 172.03 | 155.19 | B1 | |
| 168.62 | 179.18 | 173.44 | 168.48 | 153.39 | B2 | |

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| | | | | | |
|---|---|---|---|---|---|
| **170.57** | **183.24** | **174.89** | **169.63** | **154.51** | **B3** |
| **1.39** | **L.S.D 0.051.69** | | = | | |
| | **176.37** | **170.54** | **165.93** | **153.43** | **Biofertilization (C)** |
| | **0.59** | | | | **L.S.D 0.05** |

there was a significant increase in yield of one plant organic fertilization , as adding cow manure of 8 tons ha-1 significantly excelled on the rest of the treatments and recorded the highest rate of 172.40 g, while the control treatment gave the lowest rate of 154.68 g. . The reason for the superiority may be that because organic fertilizer prepares the nitrogen element that activates enzymes and is involved in the synthesis of amino acids needed to build proteins that help in tissue growth, it also increases the rates of photosynthesis process by increasing the leaf area, reflecting the increase of food manufactured in leaves and the transfer of its products to the downstream in cobs (8). The moral increase in the product's components is the number of cob, the number of rows in cobs, the number of grains in grade and the number of grains in cob. It is naturally reflected in the increase in the single plant crop. Table (4). With bio fertilization, the addition treatment (C3) was significantly excelled on the other treatments by achieving the highest rate of 176.37g, compared to the control treatment, which recorded the lowest rate of 153.43g. The reason may be to improve the physical, chemical and vital properties of the soil, which increase the readiness of nutrients in the soil reflected in the increase in the plant's vegetative total [18] including increasing plant height, number of leaves, leaf area, all reflected in increasing ingredients, including number of cobs, number of rows, number of grains in grade, number of grains in Cob, and weight of 500 grains, all of which increased the yield of one plant .The interaction between the stages of applying nano-fertilizer and organic fertilization had a significant effect on yield of one plant traits in Table (4), as the interaction (spraying S8 + S10 stage) with the addition of 8 tons ha-1 of cow waste) gave the highest rate of 175.39g, thus surpassing all interactions, while (nanospraying stage (S4+S10) with the control treatment) gave the lowest rate for the above traits of 152.33g.The interaction between the stages of applying the nano-fertilizer and the addition of different biofertilizers also had a significant effect on yield of one plant , as the interaction (spraying stage S8 + S10) with the addition (C3) bacteria + fungus) achieved the highest rate for the above trait and reached 178.48g, excelled on This applies to all the interaction treatments, while the interaction treatment (spraying stage (S4+S10) with the control treatment) gave the lowest rate for this traits and amounted to 151.57g, Table (4(The effect of the interaction between organic fertilization and bio fertilization was significant on yield of one plant of autumn seasons, as the interaction treatment (B1C3), (adding 8 tons.h-1 of cow manure with the addition of (C3) bacteria + fungi) recorded a significantly excelled on most interactions, as it gave the highest rate was 183.90g, while the control treatment (B0C0) gave the lowest average of 150.64g.The results in the table showed that the triple interaction between the three factors resulted in a significant superiority in the above traits , as the interaction treatment (A3B1C3) achieved (spraying stage (S8+S10) with the addition of organic matter 8 tons. ha-1 Cow waste with the addition of the treatment ( C3) (bacteria + fungi from bio fertilization)

recorded the highest rate of 186.18g, respectively, outperforming most the remaining treatments, while the interaction treatment (spraying stage (S4 + S10) + treatment (B0C0) recorded the lowest rate for this traits, amounting to 148.73g, Table (4)

grain yield (tons. h-1(

The results in Table (5) indicated that the nano-spraying stages differed significantly from each other in the grain yield , where the spraying stage (S8 + S10) was significantly excelled on the spraying stage (S4 + S10), recording the highest average of 9.019 tons. h-1, compared to 8.775 tons. h-1 for straight. There were no significant differences with the spraying stage (S6 + S10), which gave an average of 8.858cm2. It may be The direct role of nano fertilizer NPK in the processing of growth feeders may be due to which increases the leaf area, the chlorophyll content of the leaves and the duration of their green survival, Thus, it helped to increase the efficiency of the carbonaceous representation process, prolonged grain filling period, and the efficiency of the transfer of carbohydrates, proteins and oil to grains, resulting in an increase in the length of the Cob, the number of grains in Cob, the weight of 500 grains and the yield of one plant, reflected in the increase in the grain crop [16] The results were agreed with[12,3] .The grain yield was significantly affected by the autumn season, when organic fertilization and the addition of cow manure 8 tons ha-1 was significantly excelled on the rest of the treatments and recorded the highest rate of 9.195 tons. h-1, while the control treatment gave the lowest rate of 8.249 tons. h-1, respectively. The reason may be that organic fertilizer supplies the elements of nitrogen and phosphorus, which leads to a strong and branched root system that increases the amount of nutrients absorbed, along with an increase in the materials produced in the process of photosynthesis due to the increase in leaf area. This is accompanied by superiority in yield components, which are the number of spikes per plant, the number of rows per spike, the number of grains per row, the number of grains per spike, and the weight of 500 grains. This led to the transfer of these materials and their storage in the grains, thus leading to an increase in grain yield[3,7,8] The results agreed with [8] There was a significant increase in the leaf area of the plant with the addition of the bio fertilization used. The addition (C3) achieved a significantly excelled on the rest of the treatments in the autumn season, as the highest rate was recorded at 9.406 tons. h-1, while the control treatment gave the lowest rate 8.183 tons. h-1. The reason may also be due to an increase in leaf area and early flowering of male and female flowers, which led to an extension of the grain filling period. Or, it may be due to the increase in yield components, including the increase in the number of grains per spike, the increase in the number of grains per row, and the increase in the weight of 500 grains, thus leading to an increase in grain yield. The results agreed with [19]The results in Table (5) showed that there was a significant interaction between the stages of nano-spraying and organic fertilization, with a significant increase in the grain yield of autumn seasons, where the interaction (spraying in the S8+S10 stage) with the addition of 8 tons ha-1 of cow waste achieved the highest rate of 9.354 tons. h-1. In a row, it was excelled on all the interactions, while (the nanospray stage (S4 + S10) with the control treatment) gave the lowest rate for the above trait of 8.124 tons. h-1.The interaction between the stages of nano-spraying and bio-fertilization caused a significant increase in

the grain yield , as the interaction (spraying stage S8 + S10) with the addition (C3) bacteria + fungi) had a significant effect on

**Table (4) The effect of biological and organic fertilization and the stages of nano-fertilizer application and the interaction between them grain yield (tons. $h^{-1}$) of 2023.**

| B × A | Biofertilization (C) | | | | Organic fertilization tons.$h^{-1}$ (B) | stages of spraying nanofertilizer (A) |
|---|---|---|---|---|---|---|
| | C3 | C2 | C1 | C0 | | |
| 8.124 | 8.347 | 8.146 | 8.072 | 7.932 | B0 | S4+S10 |
| 9.073 | 9.697 | 9.372 | 9.042 | 8.179 | B1 | |
| 8.906 | 9.470 | 9.183 | 8.908 | 8.062 | B2 | |
| 8.996 | 9.654 | 9.238 | 8.927 | 8.163 | B3 | |
| 8.212 | 8.453 | 8.215 | 8.140 | 8.041 | B0 | S6+S10 |
| 9.158 | 9.797 | 9.474 | 9.139 | 8.222 | B1 | |
| 8.976 | 9.548 | 9.230 | 8.951 | 8.175 | B2 | |
| 9.082 | 9.833 | 9.284 | 8.996 | 8.216 | B3 | |
| 8.412 | 8.665 | 8.492 | 8.361 | 8.129 | B0 | S8+S10 |
| 9.354 | 9.930 | 9.712 | 9.343 | 8.430 | B1 | |
| 9.098 | 9.651 | 9.337 | 9.098 | 8.307 | B2 | |
| 9.212 | 9.830 | 9.460 | 9.217 | 8.342 | B3 | |
| 0.183 | 0.200 | =L.S.D 0.05 | | | | |
| Average effect (A) | C3 | C2 | C1 | C0 | Biofertilization (C ) / stages of spraying nanofertilizer (A) | |
| 8.775 | 9.292 | 8.985 | 8.737 | 8.084 | S4+S10 | |
| 8.858 | 9.408 | 9.051 | 8.807 | 8.164 | S6+S10 | |
| 9.019 | 9.519 | 9.250 | 9.005 | 8.302 | S8+S10 | |
| 0.172 | 0.176 | = L.S.D 0.05 | | | | |
| Average effect(B) | C3 | C2 | C1 | C0 | Biofertilizatio (C) / Organic fertilizer (B) | |
| 8.249 | 8.488 | 8.284 | 8.191 | 8.034 | B0 | |

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| | | | | | |
|---|---|---|---|---|---|
| **9.195** | **9.808** | **9.520** | **9.175** | **8.277** | **B1** |
| **8.993** | **9.556** | **9.250** | **8.986** | **8.181** | **B2** |
| **9.097** | **9.773** | **9.327** | **9.047** | **8.241** | **B3** |
| **0.074** | **0.090** | **= L.S.D 0.05** | | | |
| | **9.406** | **9.095** | **8.850** | **8.183** | **Biofertilization (C)** |
| | **0.032** | | | | **L.S.D 0.05** |

the rest of the interactions by achieving the highest rate of 9.519 tons. h-1, compared to the treatment. The control (spraying stage (S4+S10) with the control treatment) gave the lowest rate, which amounted to 8.084 tons. h-1.The grain yield was significantly affected by the double interaction between organic fertilization and bio fertilization in Table (5) , and the interaction treatment (A1C3) (addition of 8 tons of cow manure with the addition of (C3) bacteria + fungi) recorded a significantly excelled on all interactions, as It gave the highest rate, amounting to 9.808 tons. h-1, while the control treatment (A0C0) gave the lowest average, amounting to 8.034 tons. h-1.The triple interaction between the factors significantly increased the average grain yield , where the triple interaction treatment (B3A1C3) gave (spraying stage (S8+S10) with the addition of organic matter 8 tons.ha-1 Cow manure with the addition of the treatment (C3) Bacteria + fungi from biofertilization) were significantly excelled on most treatments used in the experiment, as they recorded the highest rate of 9.930 tons. h-1, while the triple interaction treatment (B1A0C0), (spraying stage (S4+S10) + treatment A0C0) recorded the lowest rate of this trait) of 7.932 tons. h-1. Table (5.(

CONCLUSION

Based on the results obtained, it can be concluded that the use of nano-fertilizers, organic fertilizers, and a mixture of bio-fertilizers has led to improved vegetative growth and its yield components for maize plants. The interaction between organic and biological fertilization leads to an increase in the nutrient content in the soil, which leads to an increase in the content of the soil and leaves of the major elements (N-P-K), thereby increasing the ability of the roots to absorb more nutrients.

Conclusion

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