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# Effect of Bio-fertilizer, Organic Matter, Nano Zinc Oxide and Interaction on the Yield its Components and Oil Yield for Sunflower Plant *Helianthus annuus* L.

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***Abstract:*** This study was conducted to know the effect of bio-fertilizer, organic matter and nanozinc oxide on yield and oil yield for sunflower. The split-split plots were used according to the randomized complete Block Design with three replicates. Where the treatments of nanozno occupied the main plots, while the organic matter control (50, 150, 300 Kg ha$^{-1}$ NPK), the poultry matter 15 ton ha$^{-1}$. the sheep matter 15 ton ha$^{-1}$ and 1/2 amount of poultry matter and 1/2 amount the sheep matter occupied sub plots , while the bio-fertilizertion treatments (0, mycorrhiza, Azo spirillum and 1/2 amount mycorrhza and 1/2 amount Azospirillum) were occupied sub-sub- plots. The results showed that the treatment of Biofertilizers mycorrhiza (C1) significantly excelled and gave the highest average of autumn and spring season for the traits of the number of seeds head$^{-1}$ (778.7, 949.6 seeds), weight of 1000 seeds (48.1,51.03 g), seeds yield (6.39, 3 ton ha$^{-1}$), oil yield (0.853,1.28 ton ha$^{-1}$),While The organic fertilization treatment (B1) was significantly excelled and given to the autumn and spring season, respectively, the highest average number of seeds per head (820.2, 1151.3 seeds), weight of 1000 seeds (49.88,54.09 g), seeds yield (6.16,2.77 ton ha$^{-1}$), oil yield (0.865, 1.31 ton ha$^{-1}$), whereas, the treatment of nano-fertilization (N1) gave a significant excelled for the traits of the number of seeds in the head (773.7, 1014.8 seeds), the weight of 1000 seeds (48.21,54.09), seeds yield (5.95,2.72), the oil yield (0.813,1.19) for both season, respectively, while the triple interaction treatment (C1B1N1) significantly excelled and giving the highest average of autumn and spring season for traits of the number of seeds per head (873.3, 1231 seeds), weight of 1000 seeds (52,57.3 g), number of seeds (7,265,3.76 ton ha$^{-1}$), oil yield (0.983,1.5 ton ha$^{-1}$) for both season, respectively

***Keywords*:** Biofertilizers, Organic matter, Nanozno, Mycorrhiza, Azosperillum

Sunflower is one the an important oil crop in the world and come second after soybean as for Iraq it is considered the first oil and production for the year 2016 was 0.9 thousand tons with cultivated area is 520 hectare (Centernal statistical organization 2018). The cultivated area in Iraq did not rise due to lack of proper agronomic practices or increasing production. The most important constraints is nutrient management and poor adoption of bio fertilizers, organic matter and nano elements particles (Farina and Moayedi 2014). The bio fertilizer increase yield by increasing availability the nutrient to absorbed by root system, (Basher and et al 2016). The organic matter added to the soil has a major impact in improving the physical, chemical and biological soil properties, increasing the activity of microorganisms and preparing the soil with many macro and micronutrients, and that the slow decomposition of the organic matter will work to prepare the plant with nutrients for a sufficient period of time and thus increase growth and yield (AL-Sultani and Hashem 2019). Nanotechnology is one of the modern technologies that have the potential to cause a new scientific revolution (Hafize and Nasrin 2018). Nano fertilizers are characterized by unique properties due to their small size and large surface area that lead to an increase in the absorption surface and then increase the photosynthesis process and thus increase production (Singh et al 2016). The research aims to know the effect of bio-fertilizer, organic matter, Nano Zinc Oxide and interaction on the yield its components and oil yield for Sunflower plant *Helianthus annuus* L.

## MATERIAL AND METHODS

The experiment field was conducted during spring and the autumn 2019 at Karbala province in Iraq. The physical and chemical traits of the soil before cultivating was recorded before both season and same is give in Table 1 random samples were taken from different places of the soil for both seasons and depth of 0- 30 cm.

The experiment was conducted in split- split plots, using The Randomized Complete Block Design (RCBD) with three replicates. The Nano Zinc Oxide, two treatments (zero and added ZNO near the roots of plant occupied the main plots (No, N1) respectively, while the levels of the organic matter (control, NPK 300, 150 and 100 Kg ha$^{-1}$ , poultry waste, sheep matter 15 ton ha$^{-1}$ and 7.5 ton ha$^{-1}$ from both poultry waste and

sheep matter occupied sub- plots which is symbolized by B0, B1, B2, B3, B4, respectively, while the bio- fertilization treatments (0, Mycorrhiza 10g, Azosperillum 10g and 1/2 (5g) Mycorrhiza, 1/2 (5g) Azo occupied sub-sub- plots, which is symbolized by C0, C1, C2, C3, respectively. The plot size was 3x4 m. The land was prepared by in two perpendiculars plowing by the moldboard plow and service operations were conducted to crop from Weeding and control when needed. The experimental units were divided to rows the spaces 0.75 m between the rows and the row was divided to holes the space 0.25 m between the pit and other, the seeds of sunflower were cultivated with rated three seeds per pit on 15/3/2019 for first season and 15/8/2019 for the second season. The studied traits were the number of seed per head, the 1000 seeds weight (g), seed yield (tons $ha^{-1}$) and oil seed (tons $ha^{-1}$) and sunflower oil percentage was also determined by the Soxholet apparatus (AOAC 1980).

## RESULTS AND DISCUSSION

**Number of seed per head:** The bio-fertilizers treatment

**Table 1.** Physical traits of the field soil for both seasons (2019)

| Season | pH | Ec ds.$m^{-1}$ | Apparent density % | Porosity (%) | Organic matter (%) | Volumetric distribution for soil separates (%) | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Clay | Silt | Sand |
| Spring | 7.3 | 3.1 | 1.7 | 36 | 1.3 | 36.2 | 35.4 | 30.9 |
| Autumn | 7.1 | 2.9 | 1.6 | 34 | 1.5 | 35.9 | 35.6 | 31.2 |

**Table 2.** Effect of biofertilizer, organic matter, Nano ZnO and interactions in the number of seed per head of sunflower

| Nano fertilizer | Organic matter | Spring agricultural season 2019 | | | | Interaction N*B | Autumn agricultural season 2019 | | | | Interaction N*B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Biofertilizers | | | | | Biofertilizers | | | | |
| | | C0 | C1 | C2 | C3 | | C0 | C1 | C2 | C3 | |
| N0 | b0 | 562.7 | 639.3 | 650.3 | 664 | 629.1 | 685.7 | 737.7 | 721.7 | 749.3 | 723.6 |
| | b1 | 726 | 825 | 808.3 | 808.3 | 791.9 | 950.3 | 1056.3 | 983.7 | 990.3 | 995.2 |
| | b2 | 718 | 802 | 805.7 | 793.7 | 779.8 | 850 | 896 | 875 | 901.3 | 880.6 |
| | b3 | 711 | 737 | 724.3 | 734 | 726.6 | 792.3 | 850.7 | 822.7 | 839 | 826.2 |
| | b4 | 724.7 | 770 | 742.3 | 750.7 | 746.9 | 830 | 924.3 | 847.7 | 837.3 | 859.8 |
| N1 | b0 | 637.3 | 776 | 734 | 719 | 716.6 | 755 | 880.3 | 796.7 | 814.7 | 811.7 |
| | b1 | 722.7 | 873.3 | 819 | 832 | 811.8 | 996.3 | 1231 | 1079.7 | 1312.3 | 1154.8 |
| | b2 | 757.7 | 804.7 | 811.7 | 769 | 785.8 | 935.7 | 976.3 | 958.7 | 976.3 | 961.8 |
| | b3 | 720 | 769 | 752.7 | 757.7 | 749.8 | 921.3 | 941 | 842 | 957.3 | 915.4 |
| | b4 | 733.7 | 792.3 | 776 | 790.7 | 773.2 | 970.3 | 1992.3 | 928.3 | 1013.3 | 978.6 |
| Average | | 701.4 | 778.7 | 762.4 | 761.9 | | 868.7 | 949.6 | 885.6 | 939.1 | |
| LSD p=0.05 | | C=11.7 | | N*B*C= n.s | | N*B= 15.4 | C=17.5 | | N*B*C= 49.5 | | N*B= 18.7 |
| Nano fertilizer | | Nano fertilizer * Biofertilizers | | | | Average of nano fertilizer | Nano fertilizer * Biofertilizers | | | | Average of nano fertilizer |
| N0 | | 688.5 | 754.7 | 746.2 | 750.1 | 734.9 | 821.7 | 893 | 850.1 | 863.5 | 857.1 |
| N1 | | 714.3 | 803.1 | 778.1 | 773.7 | 767.4 | 915.7 | 1006.2 | 921.1 | 1014.8 | 964.5 |
| LSD p=0.05 | | n.s | | | | 11.1 | 24.8 | | | | 13.8 |
| Organic matter | | Biofertilizers * Organic matter | | | | Average of organic matter | Biofertilizers * Organic matter | | | | Average of organic matter |
| b0 | | 600 | 707.7 | 692.2 | 691.5 | 672.8 | 720.3 | 809 | 759.2 | 782 | 767.6 |
| b1 | | 724.3 | 849.2 | 813.7 | 820.2 | 801.8 | 973.3 | 1143.7 | 1031.7 | 1151.3 | 1075 |
| b2 | | 737.8 | 803.3 | 808.7 | 7810.3 | 782.8 | 892.8 | 936.2 | 916.8 | 938.8 | 921.2 |
| b3 | | 715.5 | 753 | 738.5 | 745.8 | 738.2 | 856.8 | 895.8 | 832.3 | 898.2 | 870.8 |
| b4 | | 729.2 | 781.2 | 759.2 | 770.7 | 760 | 900.2 | 963.3 | 888 | 925.3 | 919.2 |
| LSD p=0.05 | | 23.3 | | | | 12.6 | 35 | | | | 15.3 |

mycorihiza gave it highest average number seeds of head recorder, (778-7 and 949.6 seeds of head for both seasons, respectively), while the plants of treatment C0 gave the lowest average recorded 701.4 and 868.7 seeds of head. The plants were treated with bio-fertilizers activates the growth by increasing the supply and available nutrients the levels of organic manure significantly affected the number of seeds the head, where (B1) chemical fertilizer (NPK 300, 150, 75 Kg $ha^{-1}$) gave the highest average number of head as compared to B0.The B2 gave the second highest seeds of head recorded 782.8 and 921.2 seeds of head with ratio of difference with (B1) 2.4 % and 16.7 % for both seasons, respectively. Plants of the treatment with nano ZnO (N1) excelled by giving it highest average number of seeds in head recorded 767.7 and 964.5 seeds for both seasons respectively, while the plants (N0) treated with nano ZnO (N0) gave the lowest average recorded 734.9 and 857.1 seeds for both seasons, respectively. The effect of interaction between bio-fertilizers and Nano ZnO did not show not significant differences. The results of the statistical analysis showed that there were no significantly differences between three factors (Nano fertilizer +Organic matter +Biofertilizers) in this study.

**Weight of 1000 seeds:** The biofertilizers treatment (*Mycorrihiza*) C1 gave the highest average of weight 1000 seeds for both seasons respectively (Table 3) while the plants of treatment C0 gave lowest average of weight for both seasons respectively, where The treatment (B1) gave highest average weight of 1000 seeds for both seasons respectively, while the treatment (B0) gave the lowest average weight of 1000 seeds. while treatment with nano ZnO (N1) excelled by giving in the highest average weight of

**Table 3.** Effect of biofertilizer, organic matter, Nano ZnO and interactions in the weight of 1000 seed g of sunflower

| Nano fertilizer | Organic matter | Spring agricultural season 2019 | | | | Interaction N*B | Autumn agricultural season 2019 | | | | Interaction N*B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Biofertilizers | | | | | Biofertilizers | | | | |
| | | C0 | C1 | C2 | C3 | | C0 | C1 | C2 | C3 | |
| N0 | b0 | 41.7 | 44.6 | 42.6 | 43.6 | 43.15 | 39.7 | 42.83 | 39.3 | 44.2 | 41.5 |
| | b1 | 47.4 | 49.4 | 48.3 | 47.6 | 48.26 | 48.73 | 52.93 | 49.9 | 53.23 | 51.2 |
| | b2 | 46.4 | 48.5 | 48.5 | 48.4 | 48 | 46.37 | 48.8 | 50.6 | 48.4 | 48.54 |
| | b3 | 44.9 | 47.5 | 46 | 45.9 | 46.12 | 44.66 | 47.33 | 46.23 | 48.5 | 46.68 |
| | b4 | 45.8 | 48.1 | 47 | 44.8 | 46.44 | 47.73 | 51.27 | 51 | 52.43 | 50.61 |
| N1 | b0 | 44 | 46.1 | 43.7 | 43.4 | 44.33 | 43.1 | 47.8 | 44.47 | 48.7 | 46.02 |
| | b1 | 50.7 | 52 | 50.4 | 51.8 | 51.49 | 54.3 | 57.3 | 55.13 | 58.17 | 56.23 |
| | b2 | 46.8 | 50.6 | 49.7 | 50 | 49.28 | 48.9 | 53.1 | 53.83 | 54.83 | 52.67 |
| | b3 | 46.9 | 49.4 | 48.5 | 48 | 48.21 | 48 | 52.93 | 49.83 | 52.47 | 51.06 |
| | b4 | 47.6 | 49.8 | 48.5 | 47.8 | 48.43 | 51.77 | 56.03 | 52.2 | 56.27 | 54.07 |
| Average | | 46.2 | 48.1 | 47.4 | 47.2 | | 47.42 | 51.03 | 49.27 | 50.73 | |
| LSD p=0.05 | | C= 0.311 | | N*B*C= 0.88 | | N*B= 0.44 | C=0.73 | | N*B*C= NS | | N*B= NS |
| Nano fertilizer | | Nano fertilizer * Biofertilizers | | | | Average of nano fertilizer | Nano fertilizer * Biofertilizers | | | | Average of nano fertilizer |
| N0 | | 45.27 | 47.63 | 46.5 | 46.15 | 46.4 | 45.43 | 48.63 | 47.41 | 49.35 | 47.7 |
| N1 | | 47.21 | 49.59 | 48.37 | 48.21 | 48.35 | 49.41 | 53.43 | 50.96 | 54.09 | 52 |
| LSD p=0.05 | | n.s | | | | 0.73 | n.s. | | | | 0.43 |
| Organic matter | | Biofertilizers * Organic matter | | | | Average of organic matter | Biofertilizers * Organic matter | | | | Average of organic matter |
| b0 | | 42.87 | 45.38 | 43.2 | 43.52 | 43.75 | 41.38 | 45.32 | 41.88 | 46.45 | 43.75 |
| b1 | | 49.08 | 50.68 | 49.81 | 49.87 | 49.88 | 51.52 | 55.12 | 52.52 | 55.7 | 53.71 |
| b2 | | 46.63 | 49.55 | 49.12 | 49.22 | 48.63 | 47.63 | 50.95 | 52.22 | 51.62 | 50.63 |
| b3 | | 45.92 | 48.47 | 47.27 | 47 | 47.17 | 46.83 | 50.13 | 48.03 | 50.48 | 48.88 |
| b4 | | 46.7 | 48.97 | 47.77 | 46.3 | 47.72 | 49.75 | 53.65 | 51.6 | 54.35 | 52.33 |
| LSD p=0.05 | | 0.623 | | | | 0.362 | 1.46 | | | | 0.63 |

1000 seeds, compared to the treatment nano ZnO (N0) gave the lowest weight of 1000 seeds. The effect of interaction between bio-fertilizer and nano ZnO was no significantly affected for both seasons respectively, The interaction between bio-fertilizer and organic matter was significantly affected in the average weight of 1000 seeds , while the treatment (B1C3) was gave the highest weight of 1000 seeds recorded 55.70 g for the second season, the triple interaction between the study factors significantly affected on the average of weight 1000 seeds for first season, the treatment N1B1C1 gave the highest average of the weight of 1000 seeds recorded 52.00 g.

**Seeds yield:** The bio-fertilizers treatment *Mycorrihiza* (C1) by giving it the highest average seeds yield for first season (Table 4). While the plants of treatment C0 gave the lowest average for both seasons respectively, As for the fertilizer NPK (B1) gave the highest average seed yield recorded 2.136 and 3.130 ton $ha^{-1}$ for both seasons respectively, treatment with Nano ZnO (N1) gave the highest average yield recorded 1.985 and 2.72 ton $ha^{-1}$ for both seasons respectively, compared to the treatment nano ZnO(N0) gave the lowest average seeds yield recorded 1.82 and 2.21 ton ha-1 for both season, respectively. Triple interaction showed significantly affect in this trait, where the treatment N1B2C1 gave the highest average of seeds yield recorded 2.422 and 3.76 ton $ha^{-1}$ for both seasons respectively, while the treatments N0B0C0 gave the lowest average of the seeds yield 1.063 and 1.500 ton $ha^{-1}$ for both seasons, respectively.

**Oil percentage:** The bio-fertilizers (C0) gave it the highest average oil percentage for the plants recorded 43.7% and 44.2% for the both seasons respectively (Table 5) while the plants of the treatment *Mychorihiza* and *Azospirullm* gave the

**Table 4.** Effect of biofertilizer, organic matter, Nano ZnO and interactions in the seed yield ton.$ha^{-1}$ of sunflower

| Nano fertilizer | Organic matter | Spring agricultural season 2019 | | | | Interaction N*B | Autumn agricultural season 2019 | | | | Interaction N*B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Biofertilizers | | | | | Biofertilizers | | | | |
| | | C0 | C1 | C2 | C3 | | C0 | C1 | C2 | C3 | |
| N0 | b0 | 3.188 | 4.781 | 4.436 | 4.633 | 4.26 | 1.5 | 1.7 | 1.5 | 1.8 | 1.61 |
| | b1 | 5.509 | 6.563 | 6.251 | 6.195 | 6.13 | 2.6 | 3 | 2.6 | 2.8 | 2.75 |
| | b2 | 5.334 | 6.227 | 6.256 | 6.151 | 5.992 | 2.1 | 2.4 | 2.36 | 1.89 | 2.29 |
| | b3 | 5.115 | 6.638 | 5.335 | 5.397 | 5.373 | 1.89 | 2.22 | 2.03 | 2.25 | 2.1 |
| | b4 | 5.31 | 5.93 | 5.586 | 5.384 | 5.553 | 2.11 | 2.54 | 2.3 | 2.34 | 2.33 |
| N1 | b0 | 4.487 | 5.777 | 5.141 | 5.214 | 5.155 | 1.74 | 2.22 | 1.89 | 2.12 | 1.99 |
| | b1 | 5.866 | 7.265 | 6.711 | 6.901 | 6.686 | 2.89 | 3.76 | 3.18 | 4.19 | 3.5 |
| | b2 | 5.426 | 6.583 | 6.32 | 6.219 | 6.137 | 2.44 | 2.74 | 2.75 | 2.86 | 2.7 |
| | b3 | 5.448 | 6.058 | 5.84 | 5.824 | 5.793 | 2.41 | 2.65 | 2.3 | 2.68 | 2.51 |
| | b4 | 5.586 | 6.391 | 6.001 | 6.047 | 6.008 | 2.68 | 3 | 2.73 | 2.8 | 2.88 |
| Average | | | | | | | 2.23 | 2.62 | 2.37 | 2.65 | |
| LSD p=0.05 | | C=0.027 | | N*B*C= 0.076 | | N*B=0.025 | C= 0.07 | | N*B*C= 0.2 | | N*B= 0.06 |
| Nano fertilizer | | Nano fertilizer * Biofertilizers | | | | Average of nano fertilizer | Nano fertilizer * Biofertilizers | | | | Average of nano fertilizer |
| N0 | | 4.891 | 5.829 | 5.572 | 5.552 | 5.46 | 2.03 | 2.36 | 2.17 | 2.3 | 2.21 |
| N1 | | 5.363 | 6.415 | 6.002 | 6.042 | 5.956 | 2.43 | 2.87 | 2.57 | 2.99 | 2.72 |
| LSD p=0.05 | | n.s | | | | 0.067 | 0.01 | | | | 0.09 |
| Organic matter | | Biofertilizers * Organic matter | | | | Average of organic matter | Biofertilizers * Organic matter | | | | Average of organic matter |
| b0 | | 3.838 | 5.229 | 4.789 | 4.924 | 4.708 | 1.59 | 1.95 | 1.71 | 1.94 | 1.8 |
| b1 | | 5.686 | 6.914 | 6.48 | 6.55 | 6.408 | 2.73 | 3.37 | 2.9 | 3.5 | 3.13 |
| b2 | | 5.38 | 6.504 | 6.29 | 6.185 | 6.065 | 2.27 | 2.56 | 2.56 | 2.59 | 2.49 |
| b3 | | 5.282 | 5.848 | 5.59 | 5.61 | 5.583 | 2.15 | 2.44 | 2.17 | 2.47 | 2.3 |
| b4 | | 5.448 | 6.161 | 5.795 | 5.715 | 5.78 | 2.4 | 2.77 | 2.52 | 2.74 | 2.6 |
| LSD p=0.05 | | 0.05 | | | | 0.02 | 0.14 | | | | 0.05 |

lowest average oil percentage for the plants recorded 41.4% and 42.3% for both season respectively. The organic matter treatment (B0) gave the highest average the oil percentage recorded 46.9% and 46.3% for both seasons respectively, while the treatments (B1) and (B3) gave the lowest average of oil percentage recorded 40.9% in the first season, but the treatment (B3) gave the lowest average of the oil percentage recorded41.33% in the second season. The treatments with Nano ZnO (N0) gave the highest average of oil percentage recorded 43% in the first season as the plants treated with Nano ZnO (N1) gave the highest average of the oil percentage recorded 43.07% in the second season, while the treatment Nano ZnO (N1) gave the lowest average of the oil percentage recorded 41.5%, 42.7%. Triple interaction treatment (N0B0C0) in the first season was excelled by giving in the highest average recorded 47.8%, while the treatments (N1B0C0) gave the highest average recorded 46.9% for the second season, compared to treatment N1B3C2 gave the lowest average recorded 39.0% and 38.8% for both seasons, respectively.

**Oil yield :** The bio-fertilizers treatment (*Mycorrihiza*) C1 by giving it the highest average the oil yield recorded 0.853 ton $ha^{-1}$ for the first season (Table 6), as well as the treatment (*Mycirrihiza* and *Azspirilum*) C3 gave the highest average the oil yield recorded 1.18 ton $ha^{-1}$ for the second season. The organic matter treatment (B1) gave the highest average oil yield recorded 0.865 and 1.31 ton $ha^{-1}$ for the both season, while the treatment (B0) gave the lowest average oil yield recorded 0.732 and 0.83 ton $ha^{-1}$ for both seasons, while the treatment with Nano Zno excelled by giving it the highest average of oil yield recorded 0.817 and 1.19 ton $ha^{-1}$ for the both season, while the NanoZno (control) N0 gave the lowest

**Table 5.** Effect of biofertilizer, organic matter, Nano ZnO and interactions in the oil percentage of sunflower

| Nano fertilizer | Organic matter | Spring agricultural season 2019 | | | | Interaction N*B | Autumn agricultural season 2019 | | | | Interaction N*B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Biofertilizers | | | | | Biofertilizers | | | | |
| | | C0 | C1 | C2 | C3 | | C0 | C1 | C2 | C3 | |
| N0 | b0 | 47.8 | 47.7 | 47.17 | 47.7 | 47.6 | 45.3 | 45.7 | 45.1 | 45.6 | 45.5 |
| | b1 | 41 | 41.8 | 42 | 41.2 | 41.5 | 41.9 | 43 | 41.3 | 42 | 42 |
| | b2 | 44.8 | 42.2 | 40.5 | 40.6 | 42 | 45.7 | 42.3 | 42.5 | 41.3 | 42.9 |
| | b3 | 45 | 40.4 | 40.8 | 40.2 | 41.6 | 45.3 | 40 | 41.6 | 39.2 | 41.5 |
| | b4 | 44.4 | 42.2 | 40.9 | 40.7 | 42.1 | 43.6 | 42.3 | 40.5 | 41.1 | 41.9 |
| N1 | b0 | 46.7 | 46.8 | 45.4 | 45.7 | 46.1 | 46.9 | 46.8 | 46.8 | 46.7 | 46.8 |
| | b1 | 39.8 | 40.6 | 41 | 39.8 | 40.3 | 41.3 | 40.2 | 41.9 | 40.2 | 40.9 |
| | b2 | 42.8 | 40.4 | 39.1 | 39.4 | 40.5 | 44.2 | 43.4 | 43.6 | 42.1 | 43.3 |
| | b3 | 42.7 | 39 | 39 | 39.9 | 40.1 | 43.7 | 38.8 | 40.8 | 41.2 | 41.1 |
| | b4 | 42.3 | 40 | 40.8 | 39.1 | 40.5 | 44.2 | 42.6 | 42.3 | 43.5 | 43.2 |
| Average | | 43.7 | 42.1 | 41.7 | 41.4 | | 44.2 | 42.5 | 42.6 | 42.3 | |
| LSD p=0.05 | | C=0.28 | | N*B*C= 0.78 | | N*B=0.025 | C=0.29 | | N*B*C=0.81 | | N*B= 0.3 |
| Nano fertilizer | | Nano fertilizer * Biofertilizers | | | | Average of nano fertilizer | Nano fertilizer * Biofertilizers | | | | Average of nano fertilizer |
| N0 | | 44.6 | 42.9 | 42.3 | 42.1 | 43 | 44.4 | 42.5 | 42.18 | 41.83 | 42.76 |
| N1 | | 42.9 | 41.3 | 41.1 | 40.8 | 41.5 | 44.06 | 42.4 | 43.08 | 42.73 | 43.07 |
| LSD p=0.05 | | n.s | | | | 0.1 | 0.42 | | | | 0.48 |
| Organic matter | | Biofertilizers * Organic matter | | | | Average of organic matter | Biofertilizers * Organic matter | | | | Average of organic matter |
| b0 | | 47.3 | 47.2 | 46.3 | 46.7 | 46.9 | 46.28 | 46.2 | 45.95 | 46.12 | 46.13 |
| b1 | | 40.4 | 41.2 | 41.5 | 40.5 | 40.9 | 41.6 | 41.63 | 41.57 | 41.11 | 41.48 |
| b2 | | 43.8 | 41.3 | 39.8 | 40 | 41.2 | 44.95 | 42.85 | 43.03 | 41.7 | 43.13 |
| b3 | | 43.8 | 39.7 | 39.9 | 40.1 | 40.9 | 44.52 | 39.43 | 41.17 | 40.2 | 41.33 |
| b4 | | 43.4 | 41.1 | 40.8 | 39.9 | 41.3 | 43.87 | 42.48 | 41.47 | 42.27 | 42.5 |
| LSD p=0.05 | | 0.6 | | | | 0.2 | 0.59 | | | | 0.25 |

average recorded 0.76 and 0.94 ton ha$^{-1}$ for the both season respectively. The triple interaction treatment N1B2C3 gave highest average of the plants recorded 1.77 ton ha$^{-1}$ in the second season, while the treatment N0B0C0 gave the lowest average recorded 0.508 and 0.620 ton ha$^{-1}$ for both seasons, respectively.

The reason for the excelled of the bio-fertilizers treatment (*Mycorrhiza*) C1 may be due to the role of bio-fertilizers which play role in increasing absorption nutrient, increases the availability of photosynthesis production and increases the effectiveness of bio-enzymes that stimulate the sink activity in receiving of manufactured materials, nutrients which was positively reflected in the increasing the studied traits, this results agrees with (Pramnik and Bera 2013, Barhamin et al 2014, Rahim Naseri et al 2015, Khan et al 2016, Saphash et al 2016, Kandekar et al 2018). The organic matter (B1) increasing the availability of nutrient elements and increasing the photosynthesis process and nutrient transfer from the source to increase the efficiency of the plant in the conversion of the largest possible from the net photosynthesis production to the stored dry matter and transferred to sink, which was positively reflected in increasing the This led to increased growth rates. These results agree with (Minggany et al 2008 ). Nano fertilizer Nano ZnO also has an important role in increasing growth, perhaps due to Nano elements play an important rolled improving the existing crop management, also using Nano fertilizer is a way to release nutrients into the soil gradually and control way, this treatment increased the yield, yield component about percentage 10 to 20 % in result of this experiment, these results agree with earlier workers (Dimkpa et al 2012, Prasad et al 2012, Rosa et al 2013, Seghatoleslami and Reza 2016 )

**Table 6.** Effect of biofertilizer, organic matter, Nano ZnO and interactions in the oil yield ton ha$^{-1}$ of sunflower

| Nano fertilizer | Organic matter | Spring agricultural season 2019 | | | | Interaction N*B | Autumn agricultural season 2019 | | | | Interaction N*B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Biofertilizers | | | | | Biofertilizers | | | | |
| | | C0 | C1 | C2 | C3 | | C0 | C1 | C2 | C3 | |
| N0 | b0 | 0.508 | 0.746 | 0.709 | 0.727 | 0.671 | 0.67 | 0.78 | 0.69 | 0.74 | 0.72 |
| | b1 | 0.752 | 0.902 | 0.874 | 0.85 | 0.845 | 1.14 | 1.26 | 1.1 | 1.18 | 1.17 |
| | b2 | 0.793 | 0.876 | 0.844 | 0.832 | 0.836 | 0.96 | 1.02 | 0.99 | 0.97 | 0.99 |
| | b3 | 0.803 | 0.757 | 0.725 | 0.722 | 0.752 | 0.83 | 0.88 | 0.86 | 0.94 | 0.88 |
| | b4 | 0.786 | 0.837 | 0.761 | 0.731 | 0.779 | 0.93 | 1.06 | 0.93 | 0.94 | 0.97 |
| N1 | b0 | 0.699 | 0.9 | 0.778 | 0.793 | 0.793 | 0.83 | 1 | 0.89 | 1.01 | 0.93 |
| | b1 | 0.766 | 0.983 | 0.887 | 0.902 | 0.885 | 1.2 | 1.5 | 1.33 | 1.74 | 1.44 |
| | b2 | 0.775 | 0.887 | 0.824 | 0.818 | 0.826 | 1.09 | 1.18 | 1.17 | 1.77 | 1.3 |
| | b3 | 0.774 | 0.786 | 0.765 | 0.774 | 0.775 | 1.05 | 1.02 | 0.94 | 1.1 | 1.03 |
| | b4 | 0.792 | 0.85 | 0.814 | 0.778 | 0.809 | 1.16 | 1.28 | 3.16 | 1.36 | 1.24 |
| Average | | 0.748 | 0.853 | 0.795 | 0.793 | | 0.99 | 1.1 | 1.01 | 1.18 | |
| LSD p=0.05 | | C=0.015 | | N*B*C=0.043 | | N*B=0.012 | C=0.03 | | N*B*C= 0.09 | | N*B= 0.03 |
| Nano fertilizer | | Nano fertilizer * Biofertilizers | | | | Average of nano fertilizer | Nano fertilizer * Biofertilizers | | | | Average of nano fertilizer |
| N0 | | 0.729 | 0.826 | 0.777 | 0.774 | 0.76 | 0.91 | 1 | 0.91 | 0.96 | 0.94 |
| N1 | | 0.761 | 0.881 | 0.814 | 0.813 | 0.817 | 1.07 | 1.2 | 1.1 | 1.4 | 1.19 |
| LSD p=0.05 | | n.s | | | | 0.033 | 0.05 | | | | 0.04 |
| Organic matter | | Biofertilizers * Organic matter | | | | Average of organic matter | Biofertilizers * Organic matter | | | | Average of organic matter |
| b0 | | 0.603 | 0.83 | 0.727 | 0.765 | 0.732 | 0.75 | 0.89 | 0.79 | 0.88 | 0.83 |
| b1 | | 0.759 | 0.943 | 0.881 | 0.876 | 0.865 | 1.17 | 1.38 | 1.21 | 1.46 | 1.31 |
| b2 | | 0.784 | 0.882 | 0.834 | 0.825 | 0.831 | 1.02 | 1.1 | 1.08 | 1.37 | 1.14 |
| b3 | | 0.789 | 0.772 | 0.745 | 0.748 | 0.763 | 0.94 | 0.95 | 0.9 | 1.02 | 0.95 |
| b4 | | 0.789 | 0.843 | 0.788 | 0.755 | 0.794 | 1.05 | 1.17 | 1.05 | 1.15 | 1.1 |
| LSD p=0.05 | | 0.03 | | | | 0.01 | 0.07 | | | | 0.03 |

## CONCLUSION

The addition of biofertilizers, organic matter and nano fertilizers significantly impact in increasing traits of the seed yield, the number of seeds per head, the weight of 1000 seeds and the oil yield. According to our results, we recommend adding biofertilizers, organic wastes and nano composition in the production of the sunflower plant.

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