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EFFECT OF MINERAL AND ORGANIC FERTILIZATION ON SOME SOIL PHYSICAL TRAITS

Ali Faleh Faisal and Hassan Hadi Hamza
Al-Mussaib Technical College, AL-Furat Al-Awsat Technical University, Iraq.

Abstract

A field experiment was conducted in Babylon province, Al-Mussaib project during the summer season of 2020. The study included two levels of NPK mineral fertilization (without fertilization, mineral fertilization) and according to the recommended for fertilizing the sunflower crop and two levels of organic fertilization (without organic fertilization, organic fertilization) at an average 6 kg of decomposed sheep manure for each experimental unit before planting and three levels of biological fertilization (without fertilization, bio fertilization soaking seeds, injecting the soil with biomaterial) (Bio Halth). Where the seeds were soaked and mixed well with bio fertilizer before cultivation for the second level, as well as the plants were injected with bio fertilizer after germination for the third level, The seeds were sown on June 1, 2020, American Flame cultivar, originating on a furrow, with a distance of 75 cm between one furrow and another, and 25 cm between a pit and another .To know the effect of mineral, organic and biological fertilization on some physical properties of soil, the one replicate included 12 treatments distributed randomly on the experimental plot. The number of the experimental plot was 36 panels with dimensions of 3 x 4 m, leaving intervals between sectors 2 m and between the experimental units 1m. Soil samples were taken from the field at the harvest stage. Samples of field soil were taken before cultivation, at a depth of 0-30 cm, and mixed well with each other to homogenize them and make a compound sample of them, and then they were air-dried and crushed and passed through a sieve with a capacity of 2 mm and a part of them was taken for laboratory analyzes to know some of the physical properties of the study soil before cultivation. The results of the experiment showed that there were significant differences between the averages of the studied traits in the presence of the mineral, organic and biological fertilization process. Organic fertilization gave the best averages, as it reached 50.45%, 1.32 g/cm^3, 24.44 mm, and 1.26 mm for the traits of concentration, porosity, bulk density, soil aggregate stability, and average Mean weight diameter compared to the control treatments which amounted to 43.71%, 1.51 g/cm^3, 13.15 mm and 0.88 mm respectively .As for the biological fertilization, it gave the best averages for the water conductivity, which amounted to 11.51 cm.h^{-1}, compared to the control treatment, which amounted to 9.10 cm.h^{-1}. The bi-interactions were significant for all soil properties, and the bi-interaction between mineral and organic fertilizers gave the best averages in most soil characteristics, which amounted to 1.40 mm and 1.24 g/cm3 for the weighted diameter average and bulk density, respectively, while the mineral and biological fertilizers gave the best average in the porosity that amounted to 52.56%. As for the organic fertilization with the biological, it gave the best average in the bulk density trait, as it reached 1.24 g/cm^3, and the triple interaction was significant for all traits.

Keywords: mineral, organic fertilization, soil physical traits

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Introduction

Mineral fertilization is a major source of plant supplies with nutrients, including microelements that play a role in the biological and physiological processes of the plant. Where nitrogen nutrition has a clear effect on plant growth, where it regulates the action of plant hormones (auxins and cytokines), which increases meristematic cell divisions. It reflects positively on the vegetative system, and it is an essential component of protoplasm and cell membranes, in the formation of nucleic acids, RNA and DNA, energy compounds ATP, NADPH2 and NADH, and in the formation of security acids, which are the cornerstone for the formation of proteins, as well as in the formation of enzymes and some vitamins, especially the complex group of vitamins B, including (B1 and B2 and B3 and vitamin H (biotin). As for phosphorous, it is one of the important elements of the plant and it is called the key to life, because of its important and direct role in most vital processes such as the formation and division of living cells, photosynthesis, and the transfer of genetic traits because it is one of the components of RNA and DNA and it participates with proteins in the formation of cellular membranes, and its role in strengthening the stems and resistance plant to lodging and infect diseases and in the formation of lateral roots and root hairs of some plants, and potassium has a role in the case of putting energy in the plant through its contribution to the processes of transport, representation, and storage, and it activates enzymes that contribute to the process of photosynthesis and contributes to the formation of nucleic acids and proteins and stimulates the formation of ATP necessary to fill the sieve tubes with materials resulting from the process of photosynthesis. where potassium maintains the balance of electrical charges in the chloroplast and organic matter has an effective role in improving the physical, chemical, and fertility properties of soil, and due to the low percentage of organic matter in the soils of dry and semi-arid climates, such as the Iraqi soil, so it is necessary to add organic matter to the soil as it increases the vitality of agricultural soils. Also, organic matter is an important source of both macro and micronutrients. The role of organic matter in improving the physical properties of soil is related to permeability, porosity, water, and air movement in the soil, root spread and penetration, and moisture retention (Wang et al., 2019).As for the role of organic matter in the chemical properties, it is represented in increasing the ionic exchange capacity of the soil and its action as a chelating substance that limits the loss and deposition of nutrients, as well as reducing the soil reaction (pH) in the root zone (Al-Shater et al., 2011), The addition of Organic fertilizer to the soil led to an increase in the amount of nitrogen, phosphorous, and potassium in the soil compared to the addition of chemical fertilizer for that current trend in sustainable farming systems. It aims to reduce the use of mineral fertilizers, whose continued addition to the soil leads to the deterioration of its fertility and pollution of the environment significantly. Therefore, the interest in adding organic fertilizers to the soil increased (Nosheen et al. 2021).

Materials and methods

The experiment location

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An experiment was conducted for the summer season on June 1, 2020, in Babylon province, Al-Mussaib project , to study the efficiency of mineral, organic and biological fertilization and to know the best fertilizers and their effect on some physical properties of soil.

Soil preparation and cultivation

The experimental land was plowed for the purpose of preparing it for cultivation by two perpendicular plows by means of the Moldboard plows, and it was smoothing with the use of disc harrows, and it was leveled by means of the leveling machine to get rid of the highs and lows in it. The experimental land was planted with the sunflower, flamy cultivar an American originating on a furrow, at a distance of 75 cm between one furrow and another, and 25 cm between one pit and another. The pits that did not germinate were re-planted after a week of germination. All crop service operations were conducted. As the land was irrigated according to the plant's need for irrigation, and the weed that appeared in the experimental land were controlled whenever necessary.

3-3 Experiment factors

1- Mineral fertilization, which includes two levels (without mineral fertilization A1, mineral fertilization A2) and according to the recommendations, where 46% urea fertilizer was added at an average of 75 kg/dunum, half of the amount when preparing the soil and the second batch after 60 days from the first batch. Superphosphate fertilizer P2O5 was added at an average of 100 kg/dunum as a source of phosphorous in one batch when preparing the soil. As for the potassium element, potassium sulfate K 43% was used at 50 kg/dunum, it was added in two batches, the first with the second date of adding nitrogen, i.e. 60 days after cultivation and the second batch before flowering.

2- The organic fertilizer includes two levels (without adding B1 organic fertilizer, B2 organic fertilizer), which is decomposed sheep manure at an average of 6 kg for each experimental unit. The organic residues were added before cultivation.The organic fertilizer for sheep manure was prepared by the anaerobic fermentation process (composting method) for a period of 45 days and Sheep manure was collected and placed on land covered with agricultural nylon and covered with nylon, taking into account the spraying of fertilizer with water and stirring it continuously with the addition of yeast and sugar in order to increase the activity of microorganisms that help decompose the fertilizer, taking into account its opening and spraying with water every week until complete decomposition.

3- Bio fertilization, which includes 3 levels (without bio-fertilization C1, bio-fertilization (soaking seeds) C2, soil injection with bio-material C3), bio-fertilization is by mixing bio-health, where the seeds were soaked and mixed well with bio-fertilizer before cultivation for the level The second, as well as the plants were injected with biological fertilization after germination to the third level.

Biohealth contents:

Tricoderma harzianum 10%, *Bacillus subtilis* 10%, Humic acid 75%, seaweed 5%, organic matter 65%, soluble potassium (K_2O) 11%, fulvic acid 6%, country of origin Germany.

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Experiment design

A factorial experiment was conducted according to the completely randomized design (RCBD)and with three replications. The use of one replicates included 12 treatments randomly distributed on the experimental plot. The number of experimental plots was 36 plots with dimensions of 3 x 4 m, leaving intervals between replicate 2 m and between the experimental units 1 m.

Analyzes and measurements

Preliminary analyzes of the soil of the field before cultivation

Samples were taken from the field soil before cultivation at a depth of 0-30 cm and mixed well with each other to homogenize them and make a composite sample of them and then air-dried,It was crushed and passed through a sieve with holes capacity of 2 mm and a part of it was taken for laboratory analyses to know some of the physical properties of the study soil before cultivation as shown in Table (1)

Each of the soil components was estimated according to its own method, as it was estimated:

• Volumes of soil particles: the volume distribution of soil particles was estimated using the pipette methods, and according to the method mentioned in Black et al. (1965).

• Organic matter: the organic matter was estimated by Black et al. (1965)

studied traits

• mean weight diameter

The mean weight diameter (MWD) was estimated as an indicator of the stability of soil aggregates according to the Chepil and Kemper method described in Black et al. (1965). Soil samples were pneumatically dried and passed through an 8 mm sieve and received on a sieve with a diameter of 4 mm and a weight of 25 g was taken from the soil model.It was moistened with water from the bottom by capillary action for 6 minutes, then transferred to a set of sieves with diameters 4.00, 2.00, 1.00, 0.50 and 0.25 mm. The sieving process was conducted by wet sieving method for 6 minutes using a wet sieving device with vibration at a speed of vibration (60 cycles) and water was drained through the device) 200 $ml.min^{-1}$).After the end of the sieving process, the remaining soil was transferred to each sieve quantitatively to a glass beaker and dried in the oven at a temperature of 105° C for the purpose of estimating the dry weight. The results were expressed at the weighted diameter ratio by applying the following equation:

$$MWD = \sum_{im1}^{n} XiWi. \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

i=1

xi average is the percentage of soil weight remaining on the sieve. and wi is the mean weight diameter(mm)

• Estimate the moisture content, bulk density, and total porosity of the soil for all experimental units as they were estimated in the initial properties of the soil.

The saturated water conductivity was estimated by taking samples of scattered soil, sifted through a sieve with a diameter of 2 mm, and saturated with capillary property. The method proposed by Klute and described in Black et al. (1965) was followed by installing the water column on the soil column and measuring the amount of water passing through the soil column during specific time

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periods until the values were established. From the time, the values of the saturated water conductivity of the soil were calculated by applying the following

K_s= (Q/At) * (L/h) ....(2)

As:-

Ks = saturated water conductivity of the soil (cm.min^{-1})

Q = volume of water passing through the soil column (cm^3)

L = length of soil column (cm)

A = cross-sectional area of the soil column (cm^3)

t = time (minutes)

h = L + height of the water column above the soil column (cm)

The stability of the soil aggregates was estimated using a sieve with an aperture diameter of 150 microns and the following equation was applied:

$$As=\frac{Residual\ weight\ in\ sieve-Sandwei}{Total\ weight-San\ \ \ weight}\times 100 \qquad ....(4)$$

(Hillel ،1980)

statistical analysis:

The data were statistically analyzed using the SPSS statistical analysis program according to the used design, and the averages were compared with the least significant difference (LSD) at the level of significance 0.05 to determine the difference between the means (Al-Rawi and Khalaf Allah, 1980).

Results and discussion

1- Mean weight diameter

It is noticed from the analysis of the variance table for the studied traits, Table (7), that there are significant differences for the trait of the average weighted diameter of mineral, organic and biological fertilization, as well as the bilateral and triple interactions. It is noticed from Table (2) that there are highly significant differences between the arithmetic averages of plants with and without mineral, organic and biological fertilization. The plants resulting from the fertilization excelled by giving them the best average, which amounted to 1.17, 1.26, and 1.22 compared to the control treatment, which amounted to 0.97, 0.88, and 0.81 respectively.As for the bi-interactions, they were highly significant for mineral and organic fertilization, mineral fertilization with bio and organic fertilization with bio fertilization by giving them the best average, which amounted to 1.40, 1.30, and 1.39 compared to the control treatment, which amounted to 0.83, 0.67 and 0.57, respectively.As for the triple interactions, they were significant among the treatments, where the triple interaction resulting from the fertilization process gave the best averages, reaching 1.54, compared to the control treatment, which amounted to 0.46.The reason for this is through the role of organic matter when it decomposes in the formation of carnivores due to microbial activity and with the participation of mineral and biological fertilization in increasing this activity.

2- Average water conductivity

It is noticed from the analysis of the variance table for the studied traits, Table (7), that there are significant differences at the probability level of 1% for the average water conductivity trait of

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mineral, organic and biological fertilization. As for the bi and triple interactions, they were significant at the 1% level as well. It is noticed from Table (3) that there are highly significant differences between the arithmetic averages in the presence of mineral, organic, and bio fertilizers and without it by giving them the highest rates, as they reached 11.05, 11.33, and 11.51 compared to the control treatment, which amounted to 10.15, 9.87 and 9.10, respectively .As for the bi-interaction, it was highly significant for mineral and organic fertilization, mineral fertilization with bio and organic with bio by giving it the highest averages, which amounted to 11.59, 12.17 and 12.07 compared to the control treatment, which amounted to 9.22, 8.97 and 7.97, respectively. The triple interactions differed significantly between treatments, as the triple interaction resulting from the fertilization process gave the highest averages, reaching 12.35, compared to the comparison treatment, which gave the lowest averages, reaching 7.93. The reason for this is through the increase of organic carbon due to the addition of organic matter and its increased decomposition resulting from the addition of mineral and biological fertilization and the role of organic carbon in increasing the water conductivity and this is consistent with what was found by Atti (2000) and Celik et al. (2004).

3- Porosity

It is noticed from the analysis of variance table for the studied characteristics, Table (7), that there were significant differences for the porosity of mineral, organic and biological fertilization, as well as bilateral and triple interactions, which were also significant. It is noticed from Table (4) that there are significant differences between the arithmetic averages with the presence of mineral, organic, and bio fertilizers and without it by giving them the highest averages, which amounted to 47.91, 50.45 and 48.65 compared to the control treatment, which amounted to 46.25, 43.71 and 44.84, respectively. As for the bi-interaction, significant differences were found for mineral and organic fertilization, mineral fertilization with bio, and organic fertilization with bio fertilization by giving it the highest averages, which amounted to 50.76, 49.85 and 52.56, compared to the control treatment, which amounted to 42.37, 44.83 and 42.43, respectively.The triple interactions differed significantly among the treatments, where the triple interaction resulting from the fertilization process gave the highest averages, which amounted to 53.66, and did not differ significantly with the triple interaction and the result of the second level of biological fertilization, which amounted to 52.66 compared to the control treatment, which gave the lowest rates, which amounted to 41.13.The reason for this is from the role of mineral fertilization in increasing the root system in the plant and thus increasing the porosity, as well as the role of biological and organic fertilization in that through increasing the activity of microorganisms and increasing the decomposition of organic matter and thus increasing the porosity and this is consistent with Sodhi (2009) and Mahmoud and Al Zaidi (2011) found. .

4- Bulk density

It is noticed from the analysis of the variance table for the studied traits (Table (7) that there are significant differences for the bulk density of mineral, organic and biological fertilization, as well as the bi and triple interactions. It is noticed from Table (5) that there are significant differences between the arithmetic averages in the presence of mineral, organic and biological fertilization and without it by giving him the best rates, which amounted to 1.37, 1.32 and 1.34 compared to the control treatment, which amounted to 1.46, 1.51 and 1.53 respectively. Significant differences were found between the bi- interaction, where the treatments resulting from the process of mineral fertilization with organic, mineral with bio, and organic with bio gave the best rates, which amounted to 1.24, 1.29 and 1.24, compared to the comparison treatment, which amounted to 1.53, 1.55 and 1.60, respectively.The triple interactions differed significantly between treatments, where the triple interaction resulting from the fertilization process gave the best averages, which amounted to 1.13, and did not differ significantly with the triple interaction with the second level of biological fertilization, which amounted to 1.15 compared to the control treatment, which amounted to 1.64. The reason for this is due to the role of single additions that gave a better bulk density than the bi-interaction. This may be due to the antagonistic action of the materials in showing this trait, but when the triple interaction worked together in order to obtain the best apparent density by increasing the vital activity of microorganisms due to the addition of the biological material and contributed to the acceleration of that mineral fertilization, which contributed to the rapid decomposition of the organic matter, and this was reflected in the improvement of the bulk density. This is consistent with what was found by Al-Salmani and Al-Bandawi (2015) and Al-Nuaimi and Al-Alousi (2016).

5- The soil aggregate stability

It is noticed from the table of analysis of variance for the studied traits in Table (7) that there are significant differences in the soil aggregate stability for mineral, organic and biological fertilization, as well as the bi and triple interactions.It is noticed from Table (6) that there are highly significant differences between the arithmetic averages in the presence of mineral, organic and biological fertilization and without it by giving them the best averages, which amounted to 22.22, 24.44, and 14.98 compared to the control treatment, which amounted to 15.38, 13.15 and 14.98, respectively. As for the bi-interactions, they were significant for mineral and organic fertilization, mineral fertilization with biological, and organic fertilization with biological by giving them the best averages, which amounted to 29.96, 25.03, and 28.31 compared to the control treatment, which amounted to 11.82, 12.60 and 11.96, respectively. As for the triple interactions, they were significant among the treatments, where the triple interaction resulting from the fertilization process gave the best averages, reaching 35.40 compared to the control treatment, which amounted to 9.63. The reason for this is through the decomposition of organic matter and the release of organic acids that help increase the soil aggregate stability and increase the concentrations of some organic compounds such as fulvic acid and some polysaccharides, which play an important role side by side in increasing the soil aggregate stability. This is consistent with what was found by Mahmoud and Al-Zaidi (2011).

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Table (2) The effect of mineral, organic and biological fertilization and their interactions on the mean weight diameter (mm)

mineral fertilization (A)	organic fertilization (B)	Bio Fertilization (C)			average B×A
		C1	C2	C3	
A1	B1	0.46	1.01	1.02	0.83
	B2	0.88	1.20	1.24	1.11
A2	B1	0.68	1.07	1.07	0.94
	B2	1.24	1.44	1.54	1.40
L.S.D(0.05)		0.33			0.019
Mineral fertilization x bio fertilization					
mineral fertilization (A)		Bio Fertilization (C)			average A
		C1	C2	C3	
A1		0.67	1.10	1.13	0.97
A2		0.96	1.25	1.30	1.17
L.S.D(0.05)		0.023			0.013
Organic Fertilization x Bio Fertilization					
organic fertilization (B)		Bio Fertilization (C)			
		C1	C2	C3	
B1		0.57	1.04	1.05	0.88
B2		1.32	1.06	1.39	1.26
L.S.D(0.05)		0.023			0.013
average C		0.81	1.18	1.22	
L.S.D(0.05)		0.016			

Table (2) The effect of mineral, organic and biological fertilization and their interactions on the soil aggregate stability ($cm.h^{-1}$)

mineral fertilization (A)	organic fertilization (B)	Bio Fertilization (C)			average B×A
		C1	C2	C3	
A1	B1	7.93	9.80	9.93	9.22
	B2	10.01	11.42	11.80	11.08
A2	B1	8.01	11.56	11.98	10.52
	B2	10.43	11.99	12.35	11.59
L.S.D(0.05)		0.173			0.099

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Mineral fertilization x bio fertilization				
mineral fertilization (A)	Bio Fertilization (C)			average A
	C1	C2	C3	
A1	8.97	10.61	10.86	10.15
A2	9.22	11.77	12.17	11.05
L.S.D(0.05)	0.122			0.070
Organic Fertilization x Bio Fertilization				
organic fertilization (B)	Bio Fertilization (C)			
	C1	C2	C3	
B1	7.97	10.68	10.96	9.87
B2	10.22	11.70	12.07	11.33
L.S.D(0.05)	0.122			0.070
average C	9.10	11.19	11.51	
L.S.D(0.05)	0.086			

Table (4) The effect of mineral, organic and biological fertilization and their interactions on Porosity%

mineral fertilization (A)	organic fertilization (B)	Bio Fertilization (C)			average B×A
		C1	C2	C3	
A1	B1	41.13	42.56	43.43	42.37
	B2	48.53	50.40	51.46	50.13
A2	B1	43.73	45.40	46.03	45.05
	B2	45.96	52.66	53.66	50.76
L.S.D(0.05)		1.368			0.790
Mineral fertilization x bio fertilization					
mineral fertilization (A)		Bio Fertilization (C)			average A
		C1	C2	C3	
A1		44.83	46.48	47.45	46.25
A2		44.85	49.03	49.85	47.91
L.S.D(0.05)		0.967			0.558
Organic Fertilization x Bio Fertilization					
organic fertilization (B)		Bio Fertilization (C)			

	C1	C2	C3	
B1	42.43	43.98	44.73	43.71
B2	47.25	51.53	52.56	50.45
L.S.D(0.05)	0.967			0.558
average C	44.84	47.75	48.65	
L.S.D(0.05)	0.684			

Table (5) The effect of mineral, organic and biological fertilization and their interactions on bulk density (g/cm^3)

mineral fertilization (A)	organic fertilization (B)	Bio Fertilization (C)			average B×A
		C1	C2	C3	
A1	B1	1.64	1.51	1.45	1.53
	B2	1.46	1.37	1.34	1.39
A2	B1	1.56	1.48	1.45	1.50
	B2	1.45	1.15	1.13	1.24
L.S.D(0.05)		0.035			0.020
Mineral fertilization x bio fertilization					
mineral fertilization (A)		Bio Fertilization (C)			average A
		C1	C2	C3	
A1		1.55	1.44	1.39	1.46
A2		1.50	1.32	1.29	1.37
L.S.D(0.05)		0.024			0.014
Organic Fertilization x Bio Fertilization					
organic fertilization (B)		Bio Fertilization (C)			
		C1	C2	C3	
B1		1.60	1.50	1.45	1.51
B2		1.45	1.26	1.24	1.32
L.S.D(0.05)		0.024			0.014
average C		1.53	1.38	1.34	
L.S.D(0.05)		0.017			

Table (6) The effect of mineral, organic and biological fertilization and their interactions on The soil aggregate stability(mm)

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mineral fertilization (A)	organic fertilization (B)	Bio Fertilization (C)			average B×A
		C1	C2	C3	
A1	B1	9.63	12.38	13.46	11.82
	B2	15.56	20.00	21.22	18.93
A2	B1	14.29	14.49	14.67	14.48
	B2	20.45	34.03	35.40	29.96
L.S.D(0.05)		0.480			0.277
Mineral fertilization x bio fertilization					
mineral fertilization (A)		Bio Fertilization (C)			average A
		C1	C2	C3	
A1		12.60	16.19	17.34	15.38
A2		17.37	24.26	25.03	22.22
L.S.D(0.05)		0.339			0.196
Organic Fertilization x Bio Fertilization					
organic fertilization (B)		Bio Fertilization (C)			
		C1	C2	C3	
B1		11.96	13.43	14.07	13.15
B2		18.00	27.01	28.31	24.44
L.S.D(0.05)		0.339			0.196
average C		14.98	20.22	21.19	
L.S.D(0.05)		0.240			

Table (7) analysis of the variance between the mean of squares for soil traits

sources of variation	d.f	The soil aggregate stability	mean weight diameter	Average water conductivity	Porosity	Bulk density
replicates	2	0.047	0.0005	0.0004	0.105	1.111
mineral fertilization	1	421.549*	0.376*	7.398*	24.667*	0.075*
organic fertilization	1	1146.838*	1.261*	19.330*	408.04*	0.350*
Bio Fertilization1	2	133.795*	0.588*	20.698*	47.61*	0.114*
Mineral×Organic	1	157.711*	0.074*	1.392*	9.404*	0.028*
mineral x bio	2	9.753*	0.017*	0.984*	6.060*	0.004*

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Organic × Bio	**2**	**62.229***	**0.033***	**1.402***	**8.325***	**0.006***
Triple interaction	**2**	**37.584***	**0.002***	**0.730***	**5.488***	**0.017***
experimental error	**22**	**0.080**	**0.0004**	**0.010**	**0.653**	**0.0004**
	35					

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