Response of sweet pepper (Capsicum animus L.) to spraying with different levels of nano-zinc and adding of poultry waste in the protected agriculture

Hussein Saad Hatim[1*], Mohamed Tarkhan Abo Almeek[2]

Abstract

A field experiment was conducted in an unheated greenhouse of private sector farms in the Al-Mussaib project area (30 km north of Babylon province) during the autumn season 2019-2020. To study the response of the sweet pepper plant. Capsicum animus L is a charisma cultivars for foliar spraying with different concentrations of nano zinc and addition of poultry waste mixed with soil, using the randomized complete block design (RCBD).The experiment included 48 treatments distributed into three replicates, and the averages were compared using the (L.S.D) test, the least significant difference at a probability level (0.05). Where the experiment included two factors, the first factor is the nano fertilizer (nano zinc sprayed on the leaves) with four concentrations (0,1,1.5,2 g. L-1) and the second factor is poultry waste (mixed with the soil) with four levels (0,12,24,36 tons.ha-1), The results indicated that the treatment of spraying with nano zinc fertilizer (2 g. L-1) was significantly excelled in increasing plant height , number of The number of branches, number of leaves and dry weight of the vegetative growth and increasing indicators of fruit number, fruit weight, early and total yield, with an increase of 115.45 cm, 19.23 branches.plant-1, 574.09 leaves.plant-1, 214.97 g.plant-1, 40.11 fruits.plant-1, 69.99 g, 0.90 kg.plant-1, 2.81 kg.plant-1 (respectively compared with control treatment, Also, the treatment of adding poultry waste at the level of (36 tons.ha-1) was significantly higher in increasing plant height rates, number of fruitful branches, number of fruiting branches, number of leaves, dry weight of the vegetative total, indicators of number of fruits, fruit weight, early and total yield above, as the increase rates reached 95.39 cm, 14.93 branches.plant-1, 454.34 leaves. plant-1, 184.70 g. plant-1, 33.82 fruits.plant-1, 65.39 g, 0.73 kg.plant-1, 2.27 kg. Nanoparticles and poultry waste at a concentration of (2 g.L-1 + 36 tons.ha-1), giving them the highest values for all the above trait.

Key Words: sweet pepper, charisma, nano fertilizer, zinc, organic fertilizer, poultry waste

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Introduction

The sweet pepper plant Capsicum annuum L. belongs to the Solanaceae family, and it is considered one of the important vegetable crops all on the world, and the original country of the pepper is Central and South America and from them it spread to Asia, Africa and the countries of the Mediterranean (Al-Khafaji and Al-Mukhtar, 1989). Pepper also contains several compounds with pharmaceutical properties, including antioxidants, anti-inflammatory, and anti-allergic (Lee et al., 2005).Pepper is grown in Iraq by the traditional open method in early spring and the protected method in early autumn. As the data of the Central Bureau of Statistics (2013) indicated that the cultivated area and the two methods of cultivation are estimated at 33,840 dunums, and a total productivity of 922,925 tons, with a yield of 27,273 kg. Dunam -1. Despite the importance of adding fertilizers for plant growth and development, as most elements of added fertilizers deteriorate their availability due to many factors, including washing,

Corresponding author: Hussein Saad Hatim
Address: [1,2]Al- Mussaib Technical College, Al-Furat Al-Awsat Technical University, Babylon province , Iraq

adsorption and sedimentation, it is necessary to reduce nutrient loss in fertilization, and increase crop productivity through adopting new applications and with the help of nanotechnology and nanomaterials, Nanofertilizers or envelopes of nano nutrients have emerged that have effective properties to accelerate crop growth and release nutrients on demand, control the release of nutrients that regulate plant growth and enhance its target activity (De Rosa et al., 2010). Nanofertilizers are the most effective and efficient fertilizer than conventional fertilizers because of their positive effect on the quality of food crops, reducing stresses in plants, less added quantities and costs, as well as the speed of their absorption by the roots, their penetration into cells, transport and representation within plant tissues (Morales-Diaz et al., 2017). Zinc is one of the essential microelements that has an important role for the plant, where it is enzyme(Catalyst) for the oxidation and reduction process in plant cells and works to activate a group of enzymes, including (Protenase, Peptidase, Dehydrogenase, Lactic acid and Enolase) and increase the necessary energy not produced by the chlorophyll pigment. Zinc is also a specialist for the carbonic anhydrase enzyme, which is an important component of chloroplasts, where it acts as a regulator of the pH reaction associated with hydrogen pumping and thus works to protect proteins from losing their nature and vitality as well as ridding plants of toxic carbon dioxide (Ali et al., 2008). Organic fertilizers added to soil are known as plant and animal waste with different degrees of decomposition that affect different soil properties, especially when added in high quantities, and there are many types of organic fertilizers used such as poultry waste , sheep and cow manure, which differ in the percentage of their nutrient content, especially N, P and K, which can be Organic fertilizers are widely used due to their availability and relatively easy access (Ayed et al., 2010).Organic matter is one of the most important determinants of soil fertility. Soils containing between 4-5% of organic matter are of the best soil types in traits of their physical, chemical and biological properties (Herencia et al., 2006). The study aims to know the effect of nanofertilizer and poultry waste on the traits of vegetative growth and yield of sweet pepper, and to reach the best combination between factors.

Materials and methods

A field experiment was conducted in an unheated greenhouse of private sector farms in the Al-Mussaib project area (30 km north of Babylon province) during the 2019-2020 autumn season, which is 54 meters long and 9 meters wide, an area of 486 m2.In the experimental cultivation season, the greenhouse soil was prepared with its deep plowing twice perpendicularly using the moldboard plow, followed by shallow plowing to break up the earthy blocks using disc harrows, then smoothing and leveling operations were conducted in a good and homogeneous manner. the 9 random samples were taken from three areas with a depth ranging from 0-30 cm, where the samples were mixed well with each other, then dried, milled and passed through a sieve with a diameter of 2 mm pit, for the purpose of analyzing and knowing the physical and chemical properties of the soil, according to the methods mentioned in (Black, 1965). As for poultry waste , it was collected from one of the private sector fields in Al-Watifiya area, and it was dried, then it was fed using an iron hammer, and passed through a sieve with a hole of 2 mm in diameter for the purpose of analyzing and knowing some of the chemical traits of poultry waste used in the study and mentioned in Table (2), After sterilization, the greenhouse was divided into 3 terraces, each 150 cm wide (divided into the terraces channel width 75 cm, while the walkway width was 75 cm),The terraces were irrigated two days before cultivated, then the seedlings produced were cultivated in one of the private farms in the Al-Azzawiya area (at the age of 45 days and after the formation of 5-6 real leaves) on both sides of the terrace on 10/4/2019 with a distance of 40 cm between them, and The experiment unit allocated 10 plants. The irrigation system drips were installed on the terraces walkway at a distance of 10 cm from the seedling site and left 1 m at the beginning and end of the greenhouse. Service operations such as patching, hoeing, and pruning were performed for all experimental units. Mineral fertilizer was added at an average of 240 kg. dunum-1 of ammonium sulfate and 160 kg. Dunum-1 of triple superphosphate in two batches during vegetative and flowering growth, As is the practice in growing the crop in greenhouses (Al-Muhammadi, 1992), the study included 48 treatments distributed in three replications, the experiment included two factors of the first factor

nanofertilizers (nano zinc sprayed on the leaves) with four concentrations (0,1,1.5,2 g.L-1) and the second factor is poultry waste (mixed with soil) With four levels (0,12,24,36 tons. ha-1), the zinc spraying process was conducted three times, the period between 20 days and the first spray was on October 25, 2019 before the emergence of flowers, and a plastic insulation was used between the experimental units when spraying to ensure The spray solution was not transferred between the treatments, and a 15 liter plastic sprinkler was used for the experiment treatments.

The spraying process was conducted early in the morning, preceded by irrigation of the field the previous day, to ensure that the stomata opened and poultry waste was added to the soil before cultivation, and the treatments were distributed randomly to the experiment units for each of the three replicates, and the experiment was conducted within the Randomized Completely Block Design(RCBD) with three replicates, the results were analyzed and the averages were compared according to the Least Significant Difference Test (LSD) at a probability level of 5% (Al-Rawi and Khalaf Allah, 2000), while the statistical program Genstat was used to analyze the data.

The studied traits

The 6 plants were selected in each experiment unit randomly and indicative signs were placed on them for the purpose of recording data for the following indicators:

1) Plant height (cm): This indicator was measured at the end of the growing season from the area of contact of the main stem with the soil to the growing Apical meristem of the plant with the metal strip.

2) The number of branches of the plant: the number of branches bearing fruits for each experimental unit was calculated, then divided by the number of plants of the unit.

3) Number of leaves per plant: The total number of leaves per plant was calculated at the end of the experiment.

4) Dry weight of Vegetative growth (g): dry the Vegetative growth of plants at a temperature of 65-70 ° C. in an electric oven for 72 hours until the weight is stable, then the dry weight was measured with a sensitive balance.

5) Number of fruits per plant: an estimate by calculating the number of fruits for the experiment unit divided by the number of its plants.

6) The fruit weight (g): an estimate by calculating the total fruit weight of the experiment unit divided by the number of fruits of the unit.

7) Early plant yield (kg): It was calculated from the first three harvests of the yield

8) Total plant yield (kg): It was calculated through the total genes of the experiment units (10) harvests divided by the number of their plants.

Table 1. Some chemical and physical traits of the study soil before cultivation

Units	Vaules	Traits	
-	7.29	pH 1:1	
ds.m-1	2.67	EC 1:1	
Cmol.charge.Kg-1soil	16.43	)CEC(Cation-exchange capacity	
g.Kg-1	14.65	Organic matter	
	28.11	Calcium carbonate	
Meq.L-1	14.03	Calcium	Dissolved cation ions
	9.0	Magnesium	
	0.72	Potassium	
	3.16	Sodium	
	Nill	Carbonate	Dissolved negative ions
	1.2	Bicarbonate	
	4.7	Sulfates	
	20.14	Chlorine	
mg.Kg-1	77	Nitrogen	elements availability
	5.60	Phosphorous	

	123.0	Potassium	
	5.47	Zinc	
g.Kg-1	516	sand	soil separates
	340	Silt	
	144	Clay	
Loam		texture	
1.48 Mega.gm-1		Bulk density	

*The analyzes were conducted in the Central Laboratory for Soil, Water and Plant Analysis, College of Agriculture, University of Baghdad.

Table 2: Some of the chemical traits of poultry waste used in the experiment.

Values	Units	Traits
1.80	ds.m-1	Electrical conductivity1:5
6.65	-	pH
8.55	-	C\N Ratio
125.30	g.Kg-1	Organic carbon
17.30	g.Kg-1	Total nitrogen
18.25	g.Kg-1	phosphorous availability
25.55	g.Kg-1	Potassium availability
0.192	g.Kg-1	zinc availability

*The analyzes were conducted in the Central Laboratory for Soil, Water and Plant Analysis, College of Agriculture, University of Baghdad

Results and discussion

1- The average of plant growth and the number of fruit branches

Table (3) showed that there are significant differences between the levels of foliar spraying with nano zinc and poultry waste mixed with soil in the traits of plant height and number of fruit branches compared to the control treatment, where the treatment of spraying with nano zinc at a concentration of (2 g.L-1) gave the highest average for the two above traits, where it was 115.45 cm and 19.23 branches. The same table indicates that the addition of poultry waste at a level of (36 tons. ha-1) led to a significant increase in those two traits above, and gave the highest average for the two above traits amounted to 95.39 cm and 14.93 branches.plant-1, compared to the control treatment, which gave the lowest average of 84.92 cm and 10.38 branch.plant -1 respectively. The results of the data analysis showed that the interaction between nano zinc and poultry waste had a significant effect on increasing the average of plant growth and the number of fruiting branches. the treatment with a concentration of (2 g.L-1 zinc + 36 tons.ha-1 poultry waste) gave the highest average, and for both traits, it reached 121.93 cm and 24.21 branches compared with the control treatment, which gave the lowest average for these two traits , it was 64.80 cm, and 3.53 branches

Table 3. The effect of nano spraying of zinc and poultry waste and their interaction on the average of plant height and the number of fruits branches of the plant

Average	the number of fruits branches(branches.plant-1)				Average	plant height(cm)				nano zinc (g.L-1)
	poultry waste(ton.ha-1)					poultry waste(ton.ha-1)				
	36	24	12	0		36	24	12	0	
6.22	8.87	6.97	5.50	3.53	67.92	71.20	68.76	66.93	64.80	0
10.53	11.67	10.96	10.10	9.40	82.29	88.21	84.93	79.90	76.12	1
14.33	14.97	14.76	14.41	13.19	96.15	100.22	97.89	95.22	91.29	1.5
19.23	24.21	19.79	17.53	15.40	115.45	121.93	118.59	113.81	107.47	2
	14.93	13.12	11.89	10.38		95. 39	92.54	88.96	84.92	Average
nano zinc=0.34 poultry waste=0.34					nano zinc=0.53 poultry waste=0.53					LSD 0.05

interaction=0.67	interaction=1.07	

2-The average number of leaves and dry weight of Vegetative growth

Table (4) indicates that there are significant differences between the levels of foliar spray with nano zinc and poultry waste mixed with soil in the trait of the number of leaves and the dry weight of the Vegetative growth, compared to the control treatment. As the treatment of spraying with nano zinc at a concentration of (2 g.L-1) gave the highest average for the two above traits , where it was 574.09 leaf.plant-1 and 214.97 g, respectively, compared to the control treatment, which gave the lowest average of 276.97 leaves.plant-1 and 150.80 g respectively. The same table shows that the addition of poultry waste at a level of (36 tons. ha-1) led to a significant increase in those two traits above, and gave the highest average for the two traits above, amounting to 454.34 leaves.plant-1 and 184.70 g, compared to control treatment, which gave the lowest average of 376.28 leaves.plant-1 and 172.07 g, respectively. The results of the data analysis showed that the interaction between nano zinc and poultry waste had a significant effect on increasing the average number of leaves and the dry weight of the vegetative total and the treatment with a concentration of (2 g. L-1 zinc + 36 tons. ha-1 poultry waste) had the highest average and for both trait, it reached 632.35 leaves. plant-1 and 220.97 g, respectively, compared to control treatment that gave the lowest average for these two trait of 235.64 leaves. plant-1 and 146.20 g

Table 4. Effect of nano spraying of zinc and poultry wastes and their interaction on average number of leaves and dry weight of Vegetative growth

Average	the number of fruits branches(branches.plant-1)				Average	plant height(cm)				nano zinc (g.L-1)
	poultry waste(ton.ha-1)					poultry waste(ton.ha-1)				
	36	24	12	0		36	24	12	0	
150.80	153.83	152.90	150.27	146.20	276.97	304.53	293.00	274.69	235.64	0
161.30	168.30	160.67	158.93	157.30	357.41	385.38	365.08	354.23	324.94	1
183.83	195.70	184.47	179.53	175.63	461.59	495.11	473.95	455.20	422.09	1.5
214.97	220.97	218.37	211.40	209.13	574.09	632.35	586.42	555.16	522.44	2
	184.70	179.10	175.03	172.07		454.34	429.62	409.82	376.28	Average
nano zinc=0.72 poultry waste=0.72 interaction=1.44					nano zinc=2.63 poultry waste=2.63 interaction=5.25					LSD 0.05

The average number of fruits and fruit weight

Table (5) shows that there are significant differences between the levels of foliar spraying with nano zinc and poultry waste mixed with soil in the trait of the number of fruits and fruit weight compared to control treatment, as the spray treatment with nano zinc at a concentration of (2 g.L-1) gave the highest average for the two above trait was 40.11 fruits. Plant-1 and 69.99 g, respectively, compared to control treatment, which gave the lowest average of 24.71 fruits.plant-1 and 52.18 g, respectively. The same table indicates that the addition of poultry waste at a level of (36 tons.ha-1) led to a significant increase in those two traits, and gave the highest average for the two traits, reaching 33.82 fruits.plant-1 and 65.39 g, compared to control treatment, which gave the lowest average of 30.37 fruits.plant-1 and 56.20 g, respectively. The results of the data analysis showed that the interaction between the two factors had a significant effect in increasing the average of the two traits, and the treatment with a concentration of (2 g. L-1 zinc + 36 tons. ha-1 poultry waste) gave the highest average and for both traits, it reached 40.62 fruits.plant -1 and 86. 74 g, respectively, compared to control treatment, which gave the lowest average for these two traits, which were 23.59 fruits.Plant-1 and 48.35 g.

Table 5. The effect of nano spraying of zinc and poultry waste and their interaction on the average number of fruits per plant and fruit weight

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Average	the number of fruits branches(branches.plant-1)				Average	plant height(cm)				nano zinc (g.L-1)
	poultry waste(ton.ha-1)					poultry waste(ton.ha-1)				
	36	24	12	0		36	42	12	0	
52.18	53.81	53.37	53.17	48.35	24.71	26.02	25.49	23.73	23.59	0
57.18	59.26	56.98	56.31	56.20	28.15	30.48	28.79	27.65	25.69	1
60.19	61.73	60.83	60.11	58.08	35.84	38.14	36.97	35.39	32.88	1.5
69.99	86.74	66.85	64.21	62.17	40.11	40.62	40.79	39.72	39.32	2
	65.39	59.51	58.45	56.20		33. 82	33.01	31.62	30.37	Average
nano zinc=2.88 poultry waste=2.88 interaction=5.75					nano zinc=0.69 poultry waste=0.69 interaction=1.37					LSD .050

Early and total yield

Table (6) indicates that there are significant differences between the levels of foliar spray with nano zinc and poultry waste mixed with soil in the early and total yield trait, compared to control treatment. The treatment of spraying with nano zinc at a concentration of (2g. L -1) gave the highest average for the two traits as they were 0.90 kg. Plant-1 and 2.81 kg. Plant-1 respectively, compared to control treatment, which gave the lowest average of 0.47 kg.L- 1 and 1.29 kg.plant-1, respectively. The same table indicates that the addition of poultry waste at a level of (36 tons. ha-1) led to a significant increase in those two characteristics above, and gave the highest average for the two traits 0.73 kg. Plant-1 and 2.27 kg. The lowest average amounted to 0.58 kg.vegetable-1 and 1.73 kg.vegetable-1 respectively. The treatment with a concentration of (2 g. L-1 zinc + 36 tons. ha-1 poultry waste) gave the highest average, and for both traits, it reached 1.13 kg.plant-1 and 3.52 kg.plant-1, respectively, compared to control treatment that gave the lowest average for these two The two traits were 0.43 kg. plant-1 and 1.14 kg.plant-1

Table 6. The effect of nano spraying of zinc and poultry wastes and their interaction on the average of early and total yield

Average	the number of fruits branches(branches.plant-1)				Average	plant height(cm)				nano zinc (g.L-1)
	poultry waste(ton.ha-1)					poultry waste(ton.ha-1)				
	36	24	12	0		36	24	12	0	
1.29	1.40	1.36	1.26	1.14	0.47	0.51	0.49	0.47	0.43	0
1.61	1.81	1.64	1.56	1.44	0.55	0.59	0.56	0.54	0.53	1
2.16	2.35	2.25	2.12	1.91	0.65	0.70	0.65	0.63	0.61	1.5
2.81	3.52	2.73	2.55	2.44	0.90	1.13	0.89	0.83	0.74	2
	2.27	1.99	1.87	1.73		0.73	0.65	0.61	0.58	Average
nano zinc=0.11 poultry waste=0.11 interaction=0.22					nano zinc=0.02 poultry waste=0.02 interaction=0.03					LSD .050

The results in Tables (3 and 4)showed that the levels of the study facters (spraying with nano zinc and adding poultry waste mixed with the soil) differed significantly in increasing the average of vegetative growth traits represented in (plant height, number of branches, number of leaves, average dry weight of vegetative growth) The plant height, Table (3), may explain the role that nanofertilizers play in improving plant growth .As the nanofertilizer have a wide spread surface area due to the small size of their particles and thus increase the effective area for the reaction as it leads to an increase in the efficiency of enzymes and then increase the biochemical reactions that in turn lead to an increase in cell division as well as the role that these minutes play in reducing or inhibiting. The formation of free radicals, as well as reducing the activity of free radicals formed and thus reduce their oxidation, as it delays the aging process, which leads to the encouragement of vegetative growth (Laware and Raskar, 2014). The active role of zinc, which is in the biological processes of making food and the work of enzymes that regulates plant growth, as well as cell elongation through the hormone Indole acetic acid, which is tryptophan (which zinc enters in its

composition) and is considered the main component of the hormone that increases plant height (Mahajan et al.2011) These results is in agree with Navarot and Levin (1976) and Abd-Alla et al (1984) (Hajira et al., 2017). Also, spraying with nano zinc fertilizer and adding poultry waste mixed with the soil can be due to the role of zinc in the formation of IAA, which is necessary in the process of fruit dropping through its role in the process of promoting fruit growth by increasing the strength of the separation zone, which leads to an increase in the number of fruits (Al-Sahaf, 1989), which is positively reflected on the plant yield as well as the role of zinc in the process of photosynthesis and the representation of chlorophyll (Jawad et al., 1988), As for the organic waste represented by poultry waste , when adding it mixed with the soil, it had a significant effect on the traits, as well as the role of organic fertilization in influencing the temperature of the soil and improving its physical and chemical traits, which leads to reducing flowering and increasing production. The increase in the number of fruits is due to the role of fertilizers. The added organic matter increases the plant height , the number of main branches and the leaf area due to the growth traits correlation, which leads to an increase in the process of carbon representation and an increase in the nutrients manufactured in the plant (Jain, 2002, Abdel-Mouty et al, 2011). These results iagrees with Porras et al. (2011; Al-Amiri, 2012 ; Nassirawi, 2015 ; Al-Muhareb, 2014; Allawi, 2013)

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