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Response of Sweet Pepper (*Capsicum Animus* L.) to Different Levels of Nano-Zinc and Poultry Manure

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Abstract: *An experiment was conducted in the unheated greenhouse in greater Mussaib project north of Babylon province at 30km in autumn season (2019-2020), to evaluate the effect of the spraying with different concentrations of nano zinc and poultry manure addition on pepper plant (Capsicum animus L.) The Randomized complete block design (RCBD). was used with three replicates per treatment, mean value were compared using the (L.S.D0.05)test. First factor was Nano-zinc fertilizer with 4 concentrations (0 ,1 ,1.5 ,2 g. L^{-1}), while second factor was poultry manure with 4 treatment (0 , 12 , 24 , 36 tons.ha^{-1}), The results indicated that spraying treatment with Nano Zn fertilizer (2 g. L^{-1}) showed a significant increase in plant height , branches No., leaves No., and plant dry matter in addition to increase fruit No. fruit weight, early and total yield, wich recorded 115.45 cm, 21.16 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 poultry manure adding at (36 tons.ha^{-1}) was significantly increasing the parameters above with average value 95.39 cm, 21.03 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 respectively. The interaction treatment between Nano-Zn and poultry manure (2 g.L^{-1} + 36 tons.ha^{-1}), gave the highest values for all the above parameters .*

Keywords: *sweet pepper; nano fertilizer; zinc; organic fertilizer; poultry manure.*

1. INTRODUCTION

The pepper plant (*Capsicum annuum* L.) belongs to the Solanaceae family, and it is considered to important vegetable crops in the world, [1]. Pepper contains several compounds with pharmaceutical properties, including antioxidants, anti-inflammatory, and anti-allergic [2]. In Iraq, Pepper is grown by the traditional open method in early spring and the protected method in early autumn. As the [3] mentioned that 8460 ha were cultivated with total productivity of 922,925 tons, with yearly 27,273000 kg. elements loss is caused by washing, adsorption and sedimentation,this is cause decrease productivity. 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 [4]. Nanofertilizers are the most effective and efficient 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 [5]. Zinc is one of the essential microelements that has an important role in the plant, where it is enzyme(Catalyst) for the oxidation and reduction process in plant

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cells and works to activate a group of enzymes, including (Protenase, Peptidase, Dehydrogenase, Lactic acid) 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 to protect proteins losing vitality as well as ridding plants of toxic carbon dioxide [6]. Organic fertilizers added to soil are considered as plant and animal manure 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 manure , sheep and cow manure, which differ in the percentage of their nutrient content, especially N, P and K, which considered as organic fertilizers are widely used due to their availability and relatively easy access [7].Organic matter is one of the most important for soil fertility, the best soils containing 4-5% of organic matter which developer physical, chemical and biological properties [8]. The objective of this study was to evaluate the effect of the Nanofertilizer and poultry manure on the some growth parameters of sweet pepper.

2. MATERIALS AND METHODS

An experiment was conducted in unheated greenhouse in greater Mussaib project at 30km north of Babylon province in autumn season 2019-2020, with area (54*9 m). The greenhouse soil was prepared with its deep plowing twice perpendicularly using the moldboard plow, followed by shallow plowing and smoothing and leveling .The samples were taken from a three regions at depth 0-30 cm, samples mixed well, milled , passed through a sieve with a diameter of 2 mm , for the purpose of analyzing and knowing,some soil parameter according to the methods mentioned in some of the chemical and physical properties which mentioned in table 1 [9] Poultry manure, it was collected from one of the private sector fields in Al-Watifiya area (north of Babylon province), and it was dried and passed through a sieve and analyzing some chemical characteristics which 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 irrigated two days before cultivated, then seedlings cultivated in private farms in Al-Azzawiya area (at the age of 45 days with 5-6 leaves) on sides of terrace at 4/10/2019 with a distance of 40 cm between them, each experimental unit include 10 plants. The irrigation system drips were installed on the terraces at a 10 cm distance. special operations as patching, hoeing were performed for all units. Urea added at 240 kg. $Dunum^{-1}$, 160 kg. $Dunum^{-1}$ of triple superphosphate, [10].The experiment include 16 experimental unit distributed in three replications with two factors, the first factor is Nanofertilizers (Nano zinc sprayed on the leaves) with 4 concentrations (0 , 1 , 1.5 , 2 $g.L^{-1}$), while the second factor is poultry manure (mixed with soil) with 4 levels (0 , 12 , 24 , 36 tons. ha^{-1}), the zinc spraying process was conducted three times, the period between them 20 days and the first spray was on October 25, 2019 before the emergence of flowers.

Spraying process was in early morning,the irrigate was at previous day to ensure that the stomata opened , poultry manure was added to the soil before cultivation, and the treatments distributed randomly to experimental units , the experiment was conducted within Randomized complete block design at three replicates, the average results analyzed according to LSD test at 5% probability level [11]. The statistical program Genstat was used to analyze the data.

Studied characteristics: 6 plants was selected from each experimental unit randomly and indicative signs were placed on them for the purpose parameter calculating :

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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) Number of branches per 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 Vegetative weight (g): dry the Vegetative growth of plants at a temperature of 65-70 ° C. in an electric oven for 72 hours until the matter is stable, then the dry matter was measured with a sensitive balance.
5) Fruit Number per plant: an estimate by calculating the number of fruits for the experiment unit divided by the number of its plants.
6) 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 fruit 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. Soil characteristics of study area

Units	Vaules	Soil characteristics	
-	7.29	pH 1;1abstract	
$ds.m^{-1}$	2.67	EC 1;1abstract	
$Cmol.charge.Kg^{-1}soil$	16.43	Cation-exchange capacity(CEC)	
$g.Kg^{-1}$	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	N	elements availability
	5.60	P	
	123.0	K	
	5.47	Zn	
$g.Kg^{-1}$	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.

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

Values	Units	Traits
1.80 *5= 9	$ds.m^{-1}$	1:5Electrical conductivity
6.65	-	pH
8.55	-	C\N Ratio
125.30	$gm.Kg^{-1}$	O.M
17.30	$gm.Kg^{-1}$	Total N
18.25	$gm.Kg^{-1}$	P availability
25.55	$gm.Kg^{-1}$	K availability
0.192	$gm.Kg^{-1}$	Zn availability

3. RESULTS AND DISCUSSION

3.1- Average of plant height and the number of branches:

Table (3) showed there are significance differences between levels of foliar spraying with Nano zinc and poultry manure mixed with soil in the plant height and branches No. compared to the control treatment, where the treatment of spraying with Nano Zn at a concentration of (2 $gm.L^{-1}$) gave highest average for the above traits was recorded 115.45 cm and 21.16 branches, respectively, compared to the control treatment, which gave the lowest average of 67.92 cm and 10.93 branches, respectively .The same table shows that addition of poultry manure at a level of (36 tons. ha^{-1}) appear a significance increase in traits above, gave the highest average amounted to 95.39 cm and 21.03 branches, compared to the control treatment, which gave the lowest average of 84.92 cm and 10.21 branches, respectively. The results showed that the interaction between Nano zinc and poultry manure appear a significant effect on increasing the average of above traits. the treatment with a concentration of (2 $gm.L^{-1}$ zinc + 36 $tons.ha^{-1}$ poultry manure) gave the highest average, for both traits it reached 121.93 cm and 26.68 branches compared with the control treatment which gave the lowest average for these two traits it was 64.80 cm, and 9.80 branches.

Table 3. Effect of nano spraying of Zn and poultry manure and interaction on average of plant height and number of branches of the pepper plant

Average	Number of branches per plant				Average	plant height(cm).				nano Zn ($gm.L^{-1}$)
	poultry manure($ton.ha^{-1}$)					poultry manure ($ton.ha^{-1}$)				
	36	24	12	0		36	24	12	0	
10.93	12.47	10.96	10.50	9.80	67.92	71.20	68.76	66.93	64.80	0
14.42	20.66	14.53	12.44	10.04	82.29	88.21	84.93	79.90	76.12	1
18.09	24.30	20.62	17.08	10.35	96.15	100.22	97.89	95.22	91.29	1.5
21.16	26.68	25.79	21.53	10.64	115.45	121.93	118.59	113.81	107.47	2
	21.03	17.97	15.39	10.21		95. 39	92.54	88.96	84.92	Average
nano zinc=0.84 poultry manure =0.84					nano zinc=0.53 poultry manure =0.53					LSD *0.05*

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interaction=1.68	interaction=1.07	

3.2- Average of leaves number and dry matter weight of Vegetative growth:

Table (4) shows there are significance differences between foliar spray level with Nano zinc and poultry manure mixed with soil on leaves number. and weight of dry matter of the vegetative growth, compared to the control treatment. As the treatment of spraying with Nano Zn (2 gm.L^{-1}) gave the highest average for two above traits , it was 574.09 leaf.$plant^{-1}$, 214.97 gm, respectively, compared to the control, which gave the lowest average of 276.97 leaf.$plant^{-1}$, 150.80 gm, respectively. The same table shows that addition of poultry manure at a level of (36 tons. ha^{-1}) gave a significant increase in those two traits above, and gave the highest average for the two traits above, amounting to 454.34 leaf.$plant^{-1}$ and 184.70 gm, compared to control treatment, which gave the lowest average of 376.28 leaf.$plant^{-1}$, 172.07 gm, respectively. The results showed the interaction between Nano zinc and poultry manure gave significant increasing effect on average leaves No., dry matter of vegetative treatment with (2 g. L^{-1} zinc + 36 tons. ha^{-1} poultry manure) gave highest average it reached 632.35 leaf. $plant^{-1}$, 220.97 gm, respectively, compared to control treatment that gave the lowest average for these two traits of 235.64 leaf. $plant^{-1}$ and 146.20 gm.

Table 4. Effect of nano spraying of Zn and poultry manure and their interaction on average number of leaves and dry matter weight of Vegetative growth of the pepper plant

Average	Dry matter weight(gm)				Average	Leaf No.$plant^{-1}$				nano Zn (gm.L^{-1})
	poultry manure (ton.ha^{-1})					poultry manure (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 manure =0.72 interaction=1.44					Nano zinc=2.63 poultry manure =2.63 interaction=5.25					LSD *0.05*

3.3- Average of fruits number and fruit weight:

Table (5) shows there are significant differences at the levels of foliar spraying with Nano zinc and poultry manure mixed with soil in the trait of fruits No. and fruit weight against to control treatment, as the spray treatment with Nano Zn (2 gm.L^{-1}) gave a highest average for two above traits was 40.11 fruits. $Plant^{-1}$ and 69.99 gm, respectively, compared to control treatment, which gave the lowest average of 24.71 fruits.$plant^{-1}$ and 52.18 gm, respectively. The same table shows that addition of poultry manure at a level of (36 tons.ha^{-1}) gave 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 gm compared to control treatment, which gave the lowest average of 30.37 fruits.$plant^{-1}$ and 56.20 gm, respectively. The results showed that the interaction between the two factors had a significant effect in increasing the average of the two traits, and the treatment with (2 gm. L^{-1} Zn + 36 tons. ha^{-1} poultry manure) gave the highest average, and for both traits, it reached

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40.62 fruits.plant $^{-1}$ and 86. 74 gm, respectively, compared to control treatment, which gave the lowest average for these two traits, which were 23.59 fruits.Plant^{-1} and 48.35 gm.

Table 5. The effect of Nano spraying of Zn and poultry manure and their interaction on the average fruits No. per plant and fruit weight of the pepper plant

Average	Fruit weight gm				Average	Plant fruit No.				nano Zn (gm.L^{-1})
	poultry manure (ton.ha^{-1})					poultry manure (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 manure =2.88 interaction=5.75					Nano zinc=0.69 poultry manure =0.69 interaction=1.37					LSD *0.05*

3.4- Early Plant and total yield

Table (6) shows there are significant differences between the levels of foliar spray with nano Zn and poultry manure 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 (2gm. L $^{-1}$) gave the highest average for the two traits as they were 0.90 kg , 2.81 kg respectively, compared to the control, which gave the lowest average of 0.47 kg , 1.29 kg respectively. The same table shows the addition of poultry manure at a level of (36 tons. ha^{-1}) gave a significant increase in two characteristics above was recorded 0.73 kg and 2.27 kg while the lowest average amounted to 0.58 kg , 1.73 kg respectively. The treatment with a concentration of (2 gm. L^{-1} Zn + 36 tons. ha^{-1} poultry manure) gave the highest average it reached 1.13 kg , 3.52 kg respectively compared to control that gave the lowest average it reached 0.43 kg and 1.14 kg.

Table 6. The effect of Nano spraying of Zn and poultry manure and their interaction on the average of early and total yield of the pepper plant

Average	Total yield kg plant^{-1}				Average	Early yield kg plant^{-1}				nano Zn (gm.L^{-1})
	poultry manure (ton.ha^{-1})					poultry manure (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 manure =0.11 interaction=0.22					Nano zinc=0.02 poultry manure =0.02 interaction=0.03					LSD *0.05*

The results in Tables (3 and 4) showed that spraying with nano zinc and adding poultry manure differed significantly in increasing the average of vegetative growth traits represented in (plant height,

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branches No. leaves No. average dry mattre of vegetative growth).As the Nanofertilizer have a high surface area due to the small size of their particles and thus increase the biochemical reactions that in turn lead to an increase in the efficiency of enzymes and cell division and the role that these minutes play in reducing. The formation of free radicals, and thus reduce their oxidation, as it delays the aging process, which leads to the encouragement of vegetative growt [12]. Zinc have the active role which is in the biological processes of making food and the work of enzymes that regulates plant growth, and cell elongation through the hormone Indole acetic acid (tryptophan) which zinc enters in its composition and is the main factore that increases plant height [13]. These results is in agree with [14] , [15] and [16]. Affectiveness of the Nano zinc fertilizer and adding poultry manure mixed with the soil can be because of the role of zinc in the formation of IAA, which is necessary fruit dropping through its role in the process of promoting fruit growth by increasing the strength of the separation zone, which leads to increase the number of fruits.[17], which is the positive effect,this reflected on the plant yield and the role of zinc in the process of photosynthesis and the representation of chlorophyll [18], As for the organic manure represented by poultry manure , when adding it mixed with the soil, it had a significant effect on the traits, and the role of organic fertilization in influencing the temperature of the soil and improving its physical and chemical properties, which leads to reducing flowering and increasing production. The increase in the fruit number is because of the role of fertilizers. The added organic matter increases the plant height, number of branches because of 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 [19] and [20]. These results agree with [21] ; [22] ; [23] ; [24] and [25].

4. CONCLUSIONS

1- Spray with Nano zinc at (2 gm.L^{-1}) gave significance increase in the growth and yield parameters of sweet pepper in this study.
2- addition of poultry manure by mixing with soil at a level (36 tons.ha^{-1}) gave significance increase in the parameters of growth and yield of sweet pepper.
3- The interaction treatment (Nano Zn at a concentration of 2gm.L^{-1} + poultry manure 36 tons.ha^{-1}) Achieved significant increase to the growth and yield parameters of sweet pepper.

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